Space Rangers!

A five-day book-based adventure for kids 6-10 years old

Explore, read, play, invent, build and learn — all about space and space exploration

Brought to you by Reading Rockets, with support from the Park Foundation

Space Rangers!

A five-day book-based adventure about space

Contents

Welcome to Space Rangers!

The best way to get kids learning is to build on their curiosity and interests. The Space Rangers program is kid-centered with an emphasis on inquiry and creativity.

We've designed the program to be user-friendly and adaptable. Use the materials each day for five days in a row, or once a week, for five weeks, (or any other way you like) to add hands-on learning to your summer programming.

Day 1: Stars and Constellations

Day 2: The Solar System

Day 3: The Moon and Apollo 11

Day 4: Mars: The Red Planet

Day 5: Space Exploration

Getting yourself ready

- You'll find an introduction to the concepts covered and recommended books for each day, as well as a list of questions to guide explorations and experiments, and a list of "space words" that kids might not be familiar with.

- Start by gathering books from the list provided from your library.
- Choose fiction and nonfiction books from the list provided.
- Read them through before you read them to the kids so you know what happens, and can spot any unfamiliar words or concepts you'll need to explain. Also, look for places to ask questions while you're reading to engage listeners.
- Think about which other parts of the program you'd like to do after reading the book(s). An activity is always a good idea, but you may also want to include writing, exploring related websites and apps, and going on a field trip, too.

Learning with the kids

- **Introduce the theme** for the day and ask kids what they know about it. (See "Activating background knowledge" on the next page.)
- **Read one or more of the books aloud and ask questions.** Listen carefully to the kids' answers. By reading to them and asking questions, you'll get them thinking about the topic, and what they want to learn. You'll also increase their understanding and excitement. Read another book and repeat.

For ideas on reading aloud and sharing nonfiction books with kids, see the Growing Readers tip sheets in the Appendix.

- **Choose a hands-on activity** to let kids explore theme. By doing an activity, the kids get to use the concepts and new words they have learned.
- **Look for a local connection.** How can you connect the ideas in the books or the activities with the kids' personal experience? Think about summer stargazing, seeing a planetarium show, or visiting a museum about space exploration.

- **Keep asking questions** throughout and listening carefully to your kids' answers.
- **Encourage kids to write** about what they are learning or curious about by using one of the writing prompts in this booklet.

- **Provide access to books about the topic** for kids to look at on their own.
- **Show kids websites and apps** that they can use to learn more about the topic and give kids time to try them out.
- **Take a field trip** to one of the recommended locations to further explore your topic for the day or theme for the week.

You can choose any of the components, all of them, or just one or two, but we recommend that you **always Start With a Book**.

Connecting the days and concepts

Ideally, you'd look through all five days of materials in advance and map out which books and activities you'd like to do. That will make it easier to help kids connect the ideas and activities each day, creating a big picture. You don't have to implement all five days, but if you do, it will make a stronger impact if you help kids connect what they are learning from day to day.

Activating background knowledge

Ask kids what they know about the topic when you are getting started. For example:

- Have you ever looked at the sky at night? What did you see? Have you seen the Moon seem to change shape?
- What is the solar system and why is the Sun at the center of it?
- How big is the solar system? How big are all the planets?
- What is the surface of the Moon like? Where do all the craters come from?
- What is gravity? Is there gravity in space? On the Moon?
- What's it like for astronauts to live and work in space?
- How does a rocket get into space?
- How do scientists make sure a spacecraft can land safely on Mars or the Moon?

You can use some of the suggestions from the toolkit's "Questions to guide explorations and experiments" if you like. Reading books and talking about what you read is another great way to activate kids' background knowledge.

Review big ideas from the day before and then make a connection. For example:

> "Yesterday we talked about the solar system and how all the planets orbit the Sun.
>
> Today we're going to look at the Moon and what happens when it orbits around our own planet Earth.
>
> As the Moon orbits around the Earth, the half of the Moon that faces the Sun will be lit up. We call the different shapes of the lit portion of the Moon that we see from Earth "phases of the Moon." Have you ever seen a full Moon or a crescent Moon? Those are two phases of the Moon."

This is a great time to check to see if your kids understood the ideas you introduced the day before, answer their questions, or identify things they'd like to explore more.

Review and teach new words

When you are pre-reading your books or looking at activities, websites, apps, or field trips, look out for words kids might not know. Take time to talk about those words and tell kids what they mean. You can do this before you read or do an activity or while you are reading or working hands-on.

If words or concepts are being repeated, ask kids if they remember what they mean and how they might be used the same way or differently in this new context.

PARK FOUNDATION

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Space Rangers toolkit authors

Tina Chovanec

Tina is the director of Reading Rockets, an award-winning national literacy initiative from WETA, Washington, DC's flagship public broadcasting station. She also created and manages Start with a Book, a summer reading and learning project.

Rachael Walker

Rachael has more than 20 years of experience developing partnerships with nonprofit organizations, corporations, and public agencies to benefit at-risk children and families. She launches national campaigns, coordinates special events, and develops original content for the National Education Association, Random House Children's Books, PBS, and WETA's Learning Media initiatives (Reading Rockets, Colorín Colorado, and AdLit.org). Visit Rachael at Belle of the Book.

Eileen Hanning

Eileen has more than 20 years of experience designing and implementing reading and hands-on-learning programs for at-risk children and training adults to help kids learn. She currently applies her curriculum design and children's book knowledge creating content, coordinating special events, and designing and implementing training as an independent consultant. Some of her clients include Reading Is Fundamental, Girls on the Run of Northern Virginia, Random House, and the American Psychological Association. Eileen holds a master's degree of education in curriculum and instruction from Trinity University in Washington, DC. Visit Eileen at Read Learn Reach.

Day 1
Stars and Constellations

Day 1
Stars and constellations

Introduction

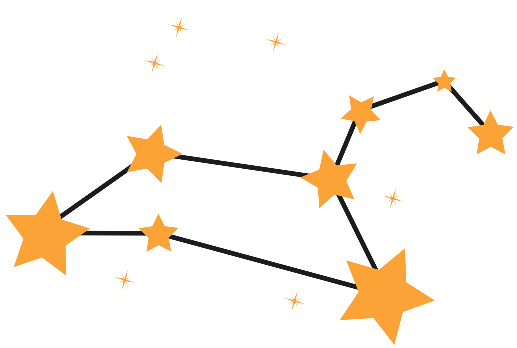
This day focuses on one of the most awesome things we can see in the night sky: **stars** and star patterns that we call **constellations**. Stars are big exploding balls of gas — mostly **hydrogen** and **helium** — held together by their own **gravity**. **Astronomers** think that there are 200 billion stars in the **Milky Way**, the **galaxy** where our own solar system lives.

Questions to guide explorations and experiments

- What is a star? Why do they shine and seem to twinkle?
- Where do stars come from?
- What is a constellation?
- Why did people name patterns of stars and create stories about them?

Books and activities

- **Books:** fiction, nonfiction and poetry all about stars, constellations, and comets
- **Activities:** explore why stars twinkle, look at constellations, and create a "star nursery" nebula



Children's Books

Fiction

- *A Big Mooncake for Little Star* by Grace Lin (Ages 4-7)
- *Blackout* by John Rocco (Ages 6-9)
- *Bright Sky, Starry City* by Uma Krishnaswami (Ages 6-9)
- *Coyote Places the Stars* by Harriet Peck-Taylor (Ages 4-8)
- *Her Seven Brothers* by Paul Goble (Ages 6-9)
- *How the Stars Fell into the Sky* by Jerrie Oughton 6-9)
- *The Story of the Milky Way* by Joseph Bruchac (Ages 6-9)

Poetry

- *Comets, Stars, the Moon, and Mars: Space Poems and Paintings* by Douglas Florian (Ages 6-9)
- *Once Upon a Star: A Poetic Journey Through Space* by James Carter (Ages 6-9)
- *Out of This World: Poems and Facts About Space* by Amy Sklansky (Ages 6-9)
- *Stuff of Stars* by Marion Bauer (Ages 6-9)

Nonfiction

- *The Big Dipper* by Franklyn Branley (Ages 6-9)
- *A Child's Introduction to the Night Sky* by Steve Parker (Ages 9-12)
- *Find the Constellations* by HA Rey (Ages 9-12)
- *Glow-in-the-Dark Constellations* by CE Thompson (Ages 6-9)
- *The Great Race: The Story of the Chinese Zodiac* by Dawn Casey (Ages 4-7)
- *A Hundred Billion Trillion Stars* by Seth Fishman (Ages 6-9)
- *The Kids' Book of the Night Sky* by Ann Love and Jane Drake (Ages 9-12)
- *Look Up! Henrietta Leavitt, Pioneering Woman Astronomer* by Robert Burleigh (Ages 6-9)
- *Once Upon a Starry Night: A Book of Constellations* by Jacqueline Mitton (Ages 6-9)
- *The Sky Is Full of Stars* by Franklyn Branley (Ages 6-9)
- *The Stars: A New Way to See Them* by HA Rey (Ages 9-12)
- *Wishing on a Star: Constellation Stories and Stargazing Activities for Kids* by Fran Lee (Ages 6-9)
- *Zoo in the Sky: A Book of Animal Constellations* by Jacqueline Mitton (Ages 6-9)

Space Words

Astronomer / Astronomy
A scientist who studies space and the Universe beyond Earth. Astronomy is the branch of science that studies space.

Atmosphere
The layer of gases surrounding Earth and other planets, held in place by gravity.

Big Dipper
Part of the constellation Ursa Major (Big Bear), made up of this constellation's seven brightest stars. These stars form a shape that looks like a ladle, or dipper.

Constellation
A group of stars in the night sky forming patterns that look like animals, objects, or characters. There are 88 official constellations. At different times of the year and in different hemispheres, different constellations can be seen in the sky.

Galaxy
A collection of billions of stars and other matter held together by gravity. Our planet Earth and the sun belong to the Milky Way galaxy. A telescope helps us see other galaxies from Earth.

Gravity
A force that pulls matter together; a force that pulls people and objects toward the ground.

Helium
A gas that is lighter than air. Balloons filled with helium will float high in the sky.

Hubble Telescope
A space telescope launched into low Earth orbit in 1990 and is still out there. The Hubble has taken thousands of images that have helped scientists and the public to understand our Universe better.

Hydrogen
A very light gas and one of the most abundant gases in the Universe.

Interstellar
The space located between stars.

Light year
The distance that light travels in one year, about 6 billion miles.

Little Dipper
The constellation Ursa Minor (Little Bear). The stars that make up this constellation also form a pattern that looks like a dipper.

Milky Way
The galaxy that contains the Earth, the Sun, and the solar system. It can be seen in the night sky as a long, cloudy group of stars.

Nebula
A cloud of dust and gas found in interstellar space. They are sometimes called "star nurseries" because stars are created there.

Orion
A large winter constellation in the northern sky. In Greek mythology, a hunter.

Polaris (North Star)
A bright star in the constellation Ursa Minor (Little Dipper). It seems to remain in a constant position in the sky; for this reason, Polaris is used for navigation.

Refract
To bend as you move from one medium to another. Example: The movement of air and dust in the atmosphere bends, or *refracts,* a star's light in different directions.

Scintillation
A spark, flash, or twinkle of light.

Star
A giant ball of hot gas that emits light and energy created through nuclear fusion at its core.

Telescope
An instrument that uses lenses and mirrors to make far away objects look larger and closer to us.

Activity 1: Twinkle, Twinkle

Introduction

Stars are so far away from Earth that, even through large telescopes, they appear only as tiny points of bright light. Stars seem to twinkle because we see them through the layers of the **atmosphere** — the gases that surround our planet.

The movement of air and dust in the atmosphere bends, or **refracts**, a star's light in different directions. Because the light is scattered by the time it reaches our eyes on Earth, stars appear to twinkle. You might think of it as the light traveling a zig-zag path to our eyes, instead of the straight path the light would travel if Earth didn't have an atmosphere.

Supplies

- 12-inch x 12-inch square of aluminum foil
- 2-quart glass bowl
- Water
- Flashlight
- Pencil (optional)

This activity works best in a darkened room

Get kids thinking

In this activity, kids will be exploring why stars appear to twinkle.

Ask kids: Have you ever looked at stars in the night sky? What have you observed?

Have you ever looked up high in the night sky at the stars and then moved your head down closer to the horizon. Do the stars seem to change?

Stars closer to the horizon will appear to twinkle more than stars higher up in the sky because there is a lot more atmosphere between you and a star near the horizon.

Activity 1: Twinkle, Twinkle

Let's get started!

Demonstrate this activity in front of the kids, and then let them try it themselves in small groups. Crumple your square of foil, then open it up, and place it on a table or on the floor. Fill your clear bowl with tap water and place it on top of the crumpled foil.

Darken the room by turning off the lights. Hold the flashlight about 12 inches above the bowl. Look at the foil through the undisturbed water. **Ask the kids:** What does the reflected light look like?

Now using your finger or a pencil, tap the surface of the water gently. Look at the foil through the moving water. **Ask the kids:** How does the reflected light look like now?

What happened? The light rays reflecting from the foil when there was a movement in water appears to blur or twinkle.

Why? The movement of the water causes the depth of the water to vary. The light rays twinkle because they bend or **refract** in different direction when it passed through the different depths of water.

This is similar to the light rays from the stars. They appear to be twinkling when you are observing from Earth because they refract differently as the light rays move through the different thickness of air in the **atmosphere.** The scientific word for this twinkling phenomenon is **scintillation**.

More activities

Do Stars Really Twinkle (video)
https://www.youtube.com/watch?v=_-GfIT6jK44

Activity 2: Explore Constellations Three Ways

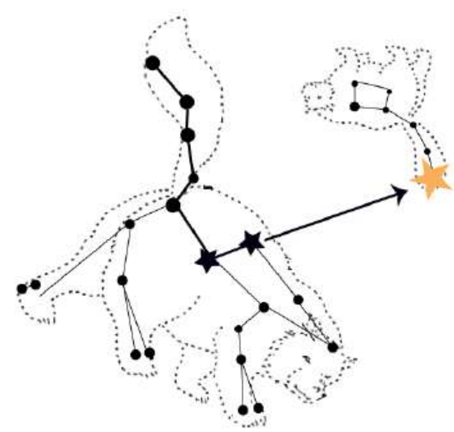
Introduction

A constellation is group of stars that make up an imaginary shape in the night sky.

In ancient times, people saw patterns of stars in the night sky that seemed to make recognizable shapes. Some of them are named after mythical heroes like Hercules and Orion the Hunter. Other star patterns are named after animals, like **Ursa Major** — the big bear.

The star patterns became a way to preserve stories, like the legend of Perseus rescuing the princess Andromeda from a sea monster named Cetus.

As astronomers began mapping the night sky, these star patterns were included in the maps and called "constellations." There are 88 official constellations, according to the International Astronomical Union. At different times of the year, different constellations can be seen in the sky.



Sailors have used constellations to help with navigation for thousands of years. It's pretty easy to spot **Polaris (North Star)** once you've found **Ursa Minor (Little Dipper).**

Get kids thinking

- Have you ever looked for the **Little Dipper** and the **North Star** in the night sky?
- Can you guess why we see different constellations in the summer night sky than we see in the fall, winter, or spring? In the summer, we can see Hercules the Hero but we can't see **Orion the Hunter** (we see Orion in the winter sky).
- Do you know any stories about constellations, like the stories of Hercules, Orion the Hunter, or Pegasus the winged horse?

This would be a great time to read a story about constellations, such as this Native American tale about the creation of the **Big Dipper** such as *Her Seven Brothers* by Paul Goble. Or you could read one of the stories from these books by Jaqueline Mitton: *Zoo in the Sky* or *Once Upon a Starry Night*.

Activity 2: Explore Constellations Three Ways

Option 1: Sidewalk Chalk Constellations

Supplies

- Summer sky constellation template and constellation card templates (provided)
- Buckets of sidewalk chalk
- Plastic buckets with rocks, pebbles, bottle caps (these are the "stars" in your constellation)

Let's get started!

In this activity, kids will build a favorite constellation outside using rocks, pebbles, bottle caps, and chalk.

Print out a copy of the summer sky constellation chart for each child. Also print out enough of the individual constellation pages so that the kids will have some options when they choose their constellation for this activity. The templates can be found after page 23.

Get everyone together in a circle, pass around the summer sky constellation charts, and talk about the different constellations on the chart. **Ask the kids:** Can you identify any of the animals or characters?

Tell the kids that you've set out copies of different constellations on the table, and invite the kids to select one that they would like to "build" outside.

Time to head outside! Bring the buckets of rocks, pebbles and bottle caps outside where there's lots of sidewalk space. Show the kids how to draw their constellation on the sidewalk, starting with the pebbles, rocks, and bottle caps (these are the "stars") and then use the chalk to connect the stars and complete their constellation. Thing big! And don't forget to have the kids write the names of their constellations in chalk next to their creation.

Activity 2: Explore Constellations Three Ways

Option 1: Sidewalk Chalk Constellations

As a group, take a walking tour of your "night sky" and encourage each child to identify their constellation, and share a story about their animal or character if they know one.

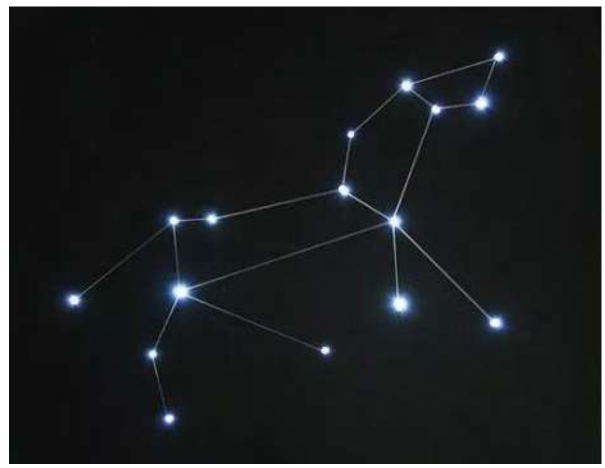
To extend this activity, you can encourage the kids to create their own constellations — the "sky's the limit" when it comes to using their imaginations!

Photo © Creekside Learning

Activity 2: Explore Constellations Three Ways

Option 2: Constellation Light Show

Supplies



- Constellation card templates (provided)
- Black construction paper (8-1/2 x 11), one sheet for each child
- Sharpened pencils or toothpicks
- Tape
- Flashlight
- Pieces of cardboard

This activity needs a darkened room

Let's get started!

In this activity, kids will prepare a constellation for a group light show in the dark.

Print out enough copies of the individual constellation pages so that the kids will have some options when they choose their constellation. The templates can be found after page 23.

Ask the kids to choose a favorite constellation. Show them how to tape their constellation template to a sheet of black paper, and then put the taped constellation on top of a piece of cardboard to protect the surface you are working on when you poke holes in the paper.

Tell the kids that each of the dots on the constellation sheet represents a star. Using a small pointed object (a pen or toothpick works well), show them how to poke holes in the dots for each star.

Then gather all the kids together in the room for the starry night show! Turn off all the lights in the room, hold your paper up to the wall and shine the flashlight behind it. Everyone will see the stars of your constellation light up on the wall. Give each child a turn to show their constellation to the group.

Activity 2: Explore Constellations Three Ways

Option 3: If I Was a Constellation (Life-Sized Constellations)

Introduction

Show kids the constellation Orion and discuss with them how the stars mark his shoulders and his belt, sword, and shield. Tell them the story of Orion and as a group, write an acrostic poem.

Supplies

- Orion constellation illustration (provided)
- Roll of black paper (at least 36" wide) — you can use white if black is not available.
- 8-1/2 x 11 white paper
- Stars cut out of yellow construction paper (about 8-10 2-inch stars per child)
- Pencils, pens, markers
- White chalk — or colored chalk if using white paper on the wall
- Tape

Let's get started!

In this activity, kids will invent their own life-sized constellations. After telling the Orion story, ask the kids to think about how they might create their own character or animal constellation by posing with their bodies.

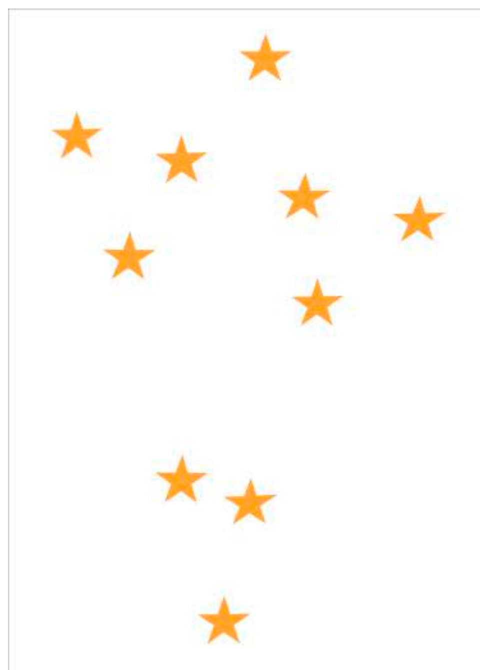
Tape kid-sized sheets of paper to the wall and have each child stand in the constellation pose of their own invention in front of their paper. Mark the main points of the body with pencil or marker — just make a small "X".

Activity 2: Explore Constellations Three Ways

Option 3: If I Was a Constellation

Next, have the kids tape the paper stars to the main points on the body, on top of the "X". They can connect the stars with the marker if they'd like to. **Tell kids:** That's you as a life-sized constellation!

Ask the kids to give their constellation a name, write it on a sheet of paper in acrostic style (vertically, and then write a descriptive acrostic poem for their invented constellation.



More constellation activities

Constellation Centerpiece (PBS Parents)
http://www.pbs.org/parents/adventures-in-learning/2014/06/create-constellation-centerpiece/

Constellation Viewers (Literary Hoots)
http://www.literaryhoots.com/2015/05/constellations-astronomy-for-kids.html

Activity 3: Nebulas — Where Stars Are Born

Introduction

A **nebula** is an **interstellar** cloud of dust and gas. Some nebulas are called “star nurseries” because that’s where stars are formed, or "born." Our own Sun was born 4.6 billion years ago!

Supplies (for each child)

- Clear glass jar with a lid
- Plastic spoon
- Water
- Tempera paint (at least 2 colors, blues, purples, and pinks work well)
- Glitter
- Cotton balls (about 18 per child, depending on the size of the jar)

Get kids thinking

In this activity, kids will create a model of a nebula. A nebula looks like a big cloud of dust and gas located in **interstellar** space. They are very far away — the closest one to Earth is called the **Helix Nebula** and it is 700 **light years** away. That means even if you could travel at the speed of light, it would take you 700 years to get there!

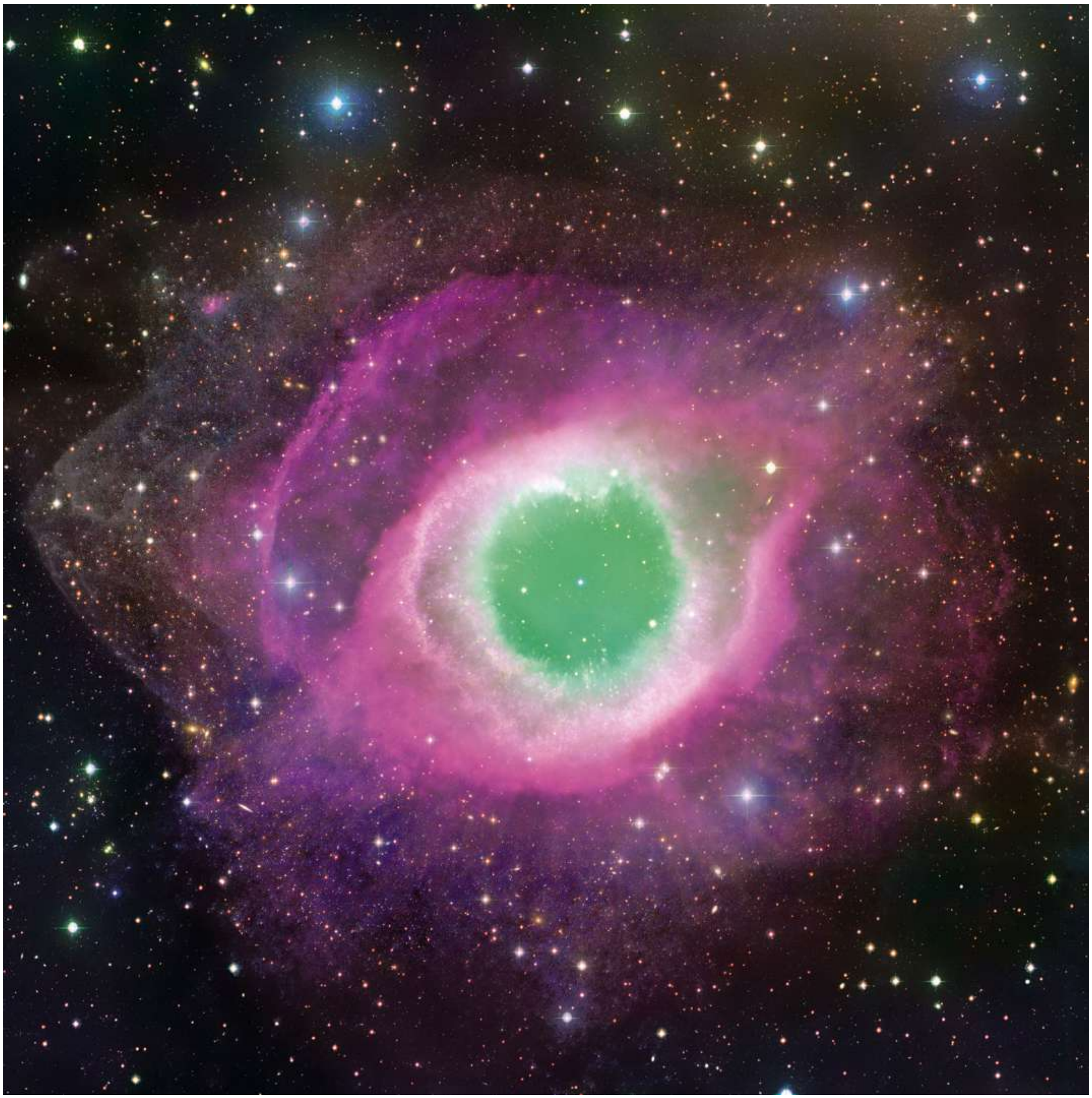
Ask kids: If nebulas are so far away, how do we know what they look like? **Astronomers** use very powerful space telescopes, such as the **Hubble telescope**, to take pictures of nebulas.

Share photographs of the Helix Nebula and the Orion Nebula (see pages 17-18). If you have access to the Internet, watch this video from NASA, Flight Through the Orion Nebula.

https://www.smithsonianmag.com/smart-news/take-trip-through-orion-nebula-nasas-awe-some-video-1-180967825/

Activity 3: Nebulas — Where Stars Are Born

Helix Nebula



Activity 3: Nebulas — Where Stars Are Born

Orion Nebula

On a clear night, if you look at the constellation **Orion**, you might get a glimpse of a star nursery. Below Orion's belt (near the tip of his sword) about 1,350 light years from Earth, the nebula looks like a mudge in the sky. But that hazy smudge is Orion Nebula, which creates some of the **Milky Way**'s newest stars.

Activity 3: Nebulas — Where Stars Are Born

Let's get started!

Have kids fill one-third of their glass jars with water. Tell kids to add a few drops of tempera paint to the jar and stir.

Then have kids add 3-6 cotton balls (depending on the size of the jar) to the water mixture in the jar, pressing down with the spoon. Next, ask kids to sprinkle in about a teaspoon of glitter.

Tell the kids to repeat steps 1-4 two more times, or until their jar is full. Screw on the lid and your nebula jar is ready to display.

The nebula jar is a colorful (and even calming) object for a child's room, plus they can proudly say to visitors, "look, I made a nebula" and then explain what that word means!

Photo © PBS Parents

Writing About Stars

Writing helps kids process and solidify new knowledge and gives them an opportunity to use new vocabulary and concepts. Offer one or more of these prompts or questions to get your Space Rangers writing.

Write a constellation myth

Talk about what a myth is — a made-up story that explains the existence of something in nature, such as where thunder comes from or how the Milky Way formed. Myths often feature supernatural and heroic characters who have the power to make amazing things things happen.

Next, read a constellation myth to the group, and tell the kids that they'll be writing their own constellation myths.

Give the kids a copy of the Summer Star Chart (see the next page) and paper, pens, pencils, and/or markers for writing and drawing.

Look together at the stars on your star chart. What kinds of patterns do the kids see? Ask each child to find a cluster of stars and design a new constellation with its own modern-day myth. The constellation myth should explain how and why this particular constellation is in the sky.

Share your stories in a group circle.

Variation: Look at the Summer Star chart. Find two constellations that are neighbors and write a new story about the two characters together.

Writing About Stars

Blackout poetry

Blackout poetry is like a treasure hunt since you find hidden meanings and secret messages in unlikely places. It also creates a beautiful "night sky" — with words as the twinkling stars of your poem.

Create an example for the kids as you explain the activity.

Supplies (for each child)

- Old newspapers or magazines
- Thin and thick black markers
- Highlighters (optional)

How to

1. Select a newspaper or magazine page.
2. Look at all of the words on the page.
3. Go back over the page, and with a thin black marker draw a box around the words that you want in your poem.
4. Color in (black out) the rest of the words on the page with the thick black marker, leaving just the words you selected.
5. Highlight all or some of the words, if you like, to create a more colorful effect.

Kid-friendly Websites and Apps

Websites

Constellations (NASA Space Place)
https://spaceplace.nasa.gov/search/constellations/

What Is a Nebula? (NASA Space Place)
https://spaceplace.nasa.gov/nebula/en/

This Week's Sky at a Glance (Sky and Telescope)
https://www.skyandtelescope.com/observing/sky-at-a-glance/

How to Find the Summer Constellations (NPR)
https://www.npr.org/2018/06/26/621935519/how-to-find-the-summer-constellations-360-video

Stargazing (Ranger Rick, National Wildlife Federation)
https://rangerrick.org/crafts_activities/try-stargazing/

Flight Through the Orion Nebula (Smithsonian)
https://www.smithsonianmag.com/smart-news/take-trip-through-orion-nebula-nasas-awe-some-video-1-180967825/

How Many Stars Are There? (It's Okay to Be Smart, PBS Digital Studio)
https://www.pbs.org/video/its-okay-be-smart-how-many-stars-are-there/

Super Stars: Constellations (Crash Course Kids)
https://thekidshouldseethis.com/post/what-is-a-constellation-crash-course-kids

DK Find Out: Constellations (DK Publishing)
https://www.dkfindout.com/us/space/constellations/

Kid-friendly Websites and Apps

Stargazing apps

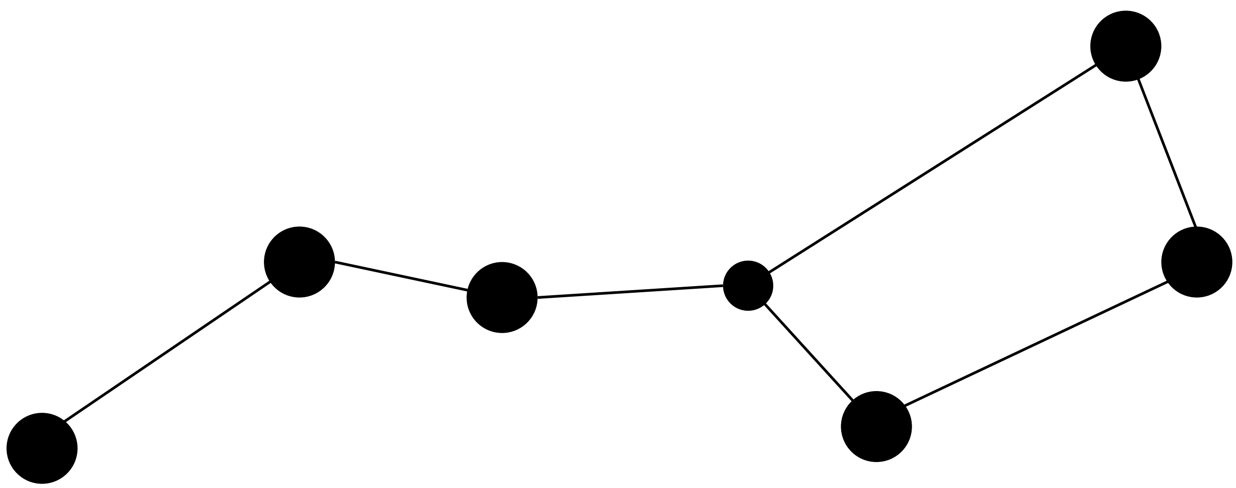
Each of these uses GPS to instantly map the sky from where you are standing.

Star Chart (Android) $
https://www.commonsensemedia.org/app-reviews/star-chart

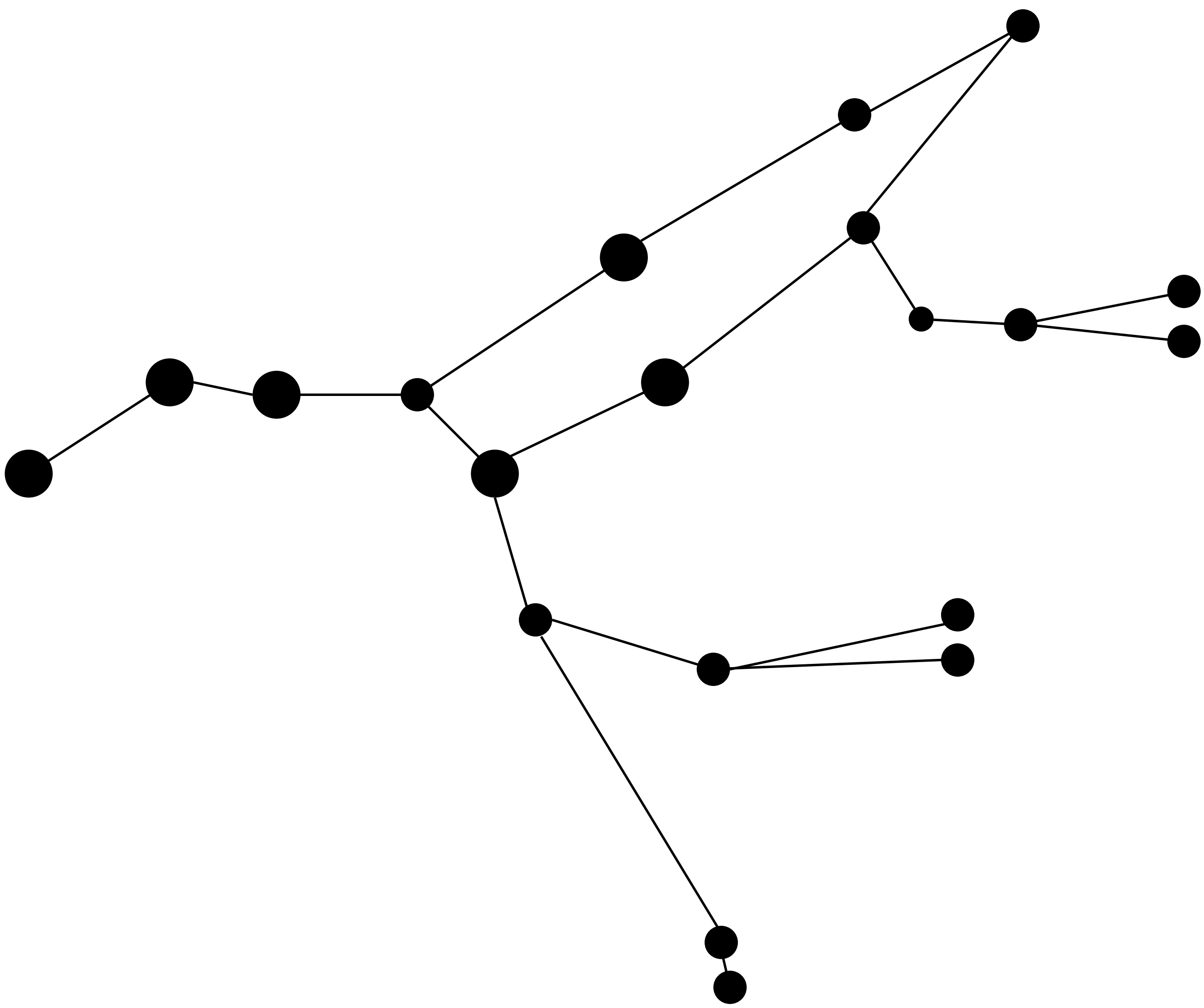
Sky Map (Android)
https://www.commonsensemedia.org/app-reviews/sky-map

Star Walk Astronomy Guide (Apple) $
https://www.commonsensemedia.org/app-reviews/meet-the-insects-water-grass-edition

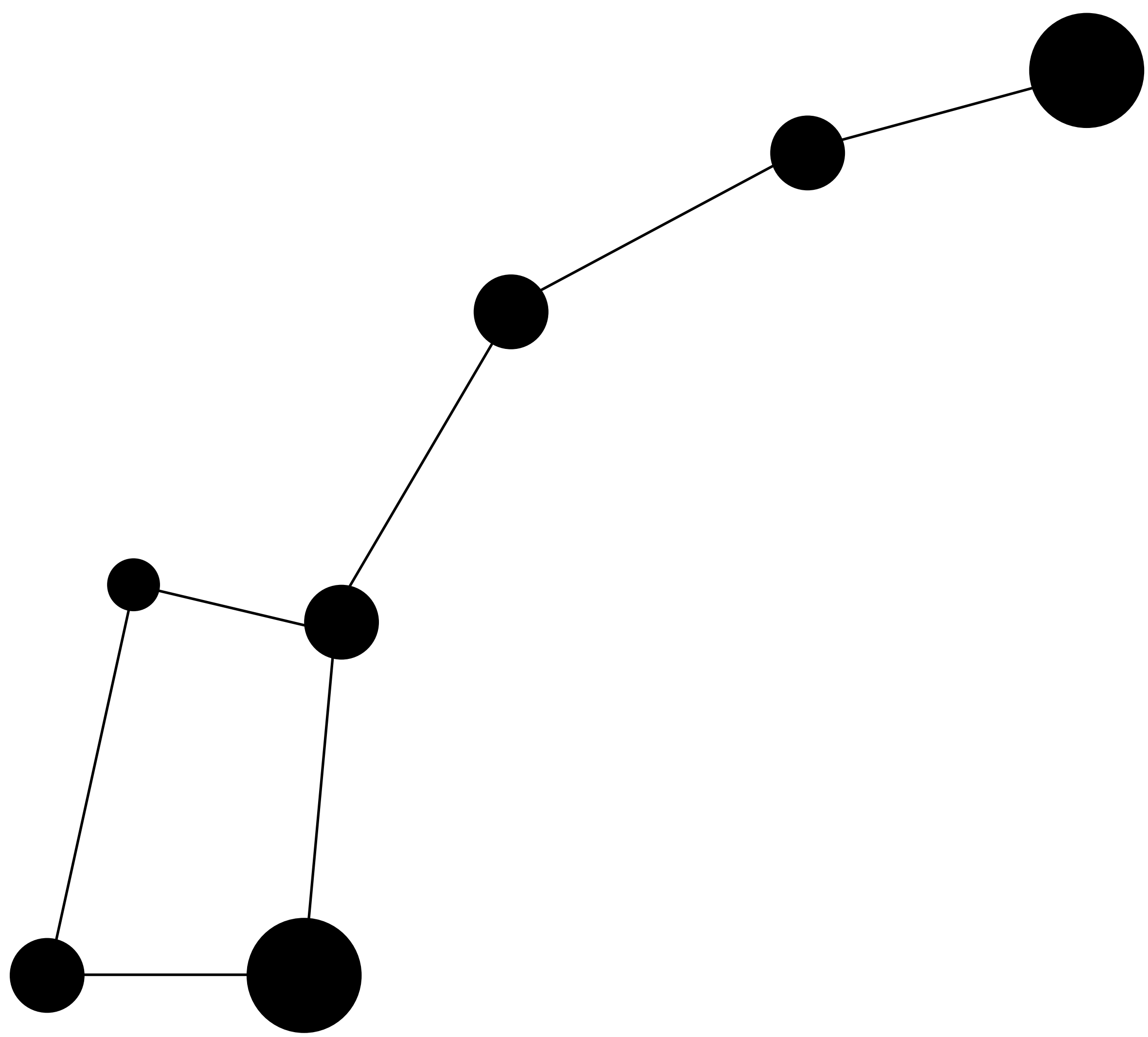
Redshift Astronomy (Apple) $
https://www.commonsensemedia.org/app-reviews/redshift-astronomy



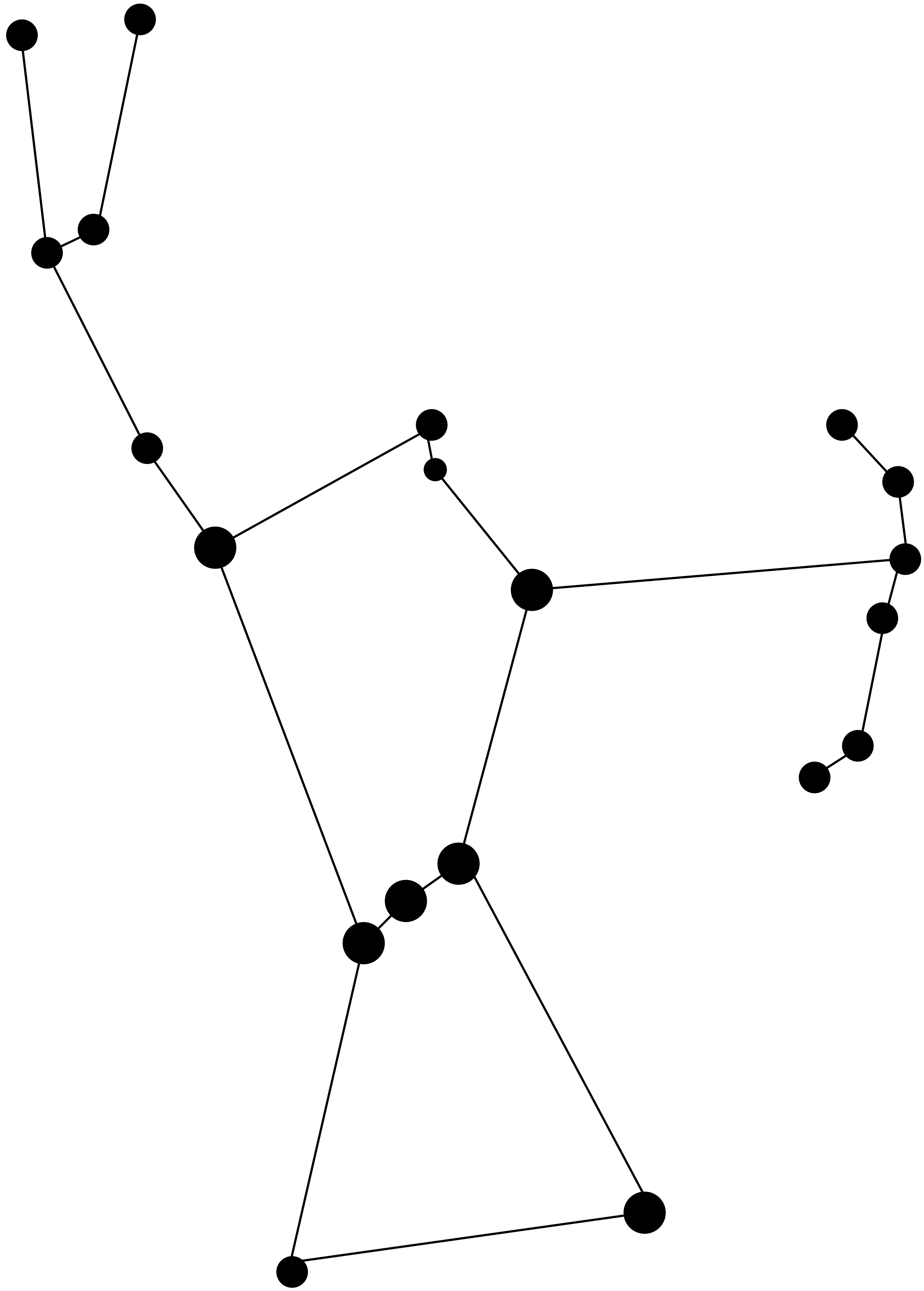
Big Dipper



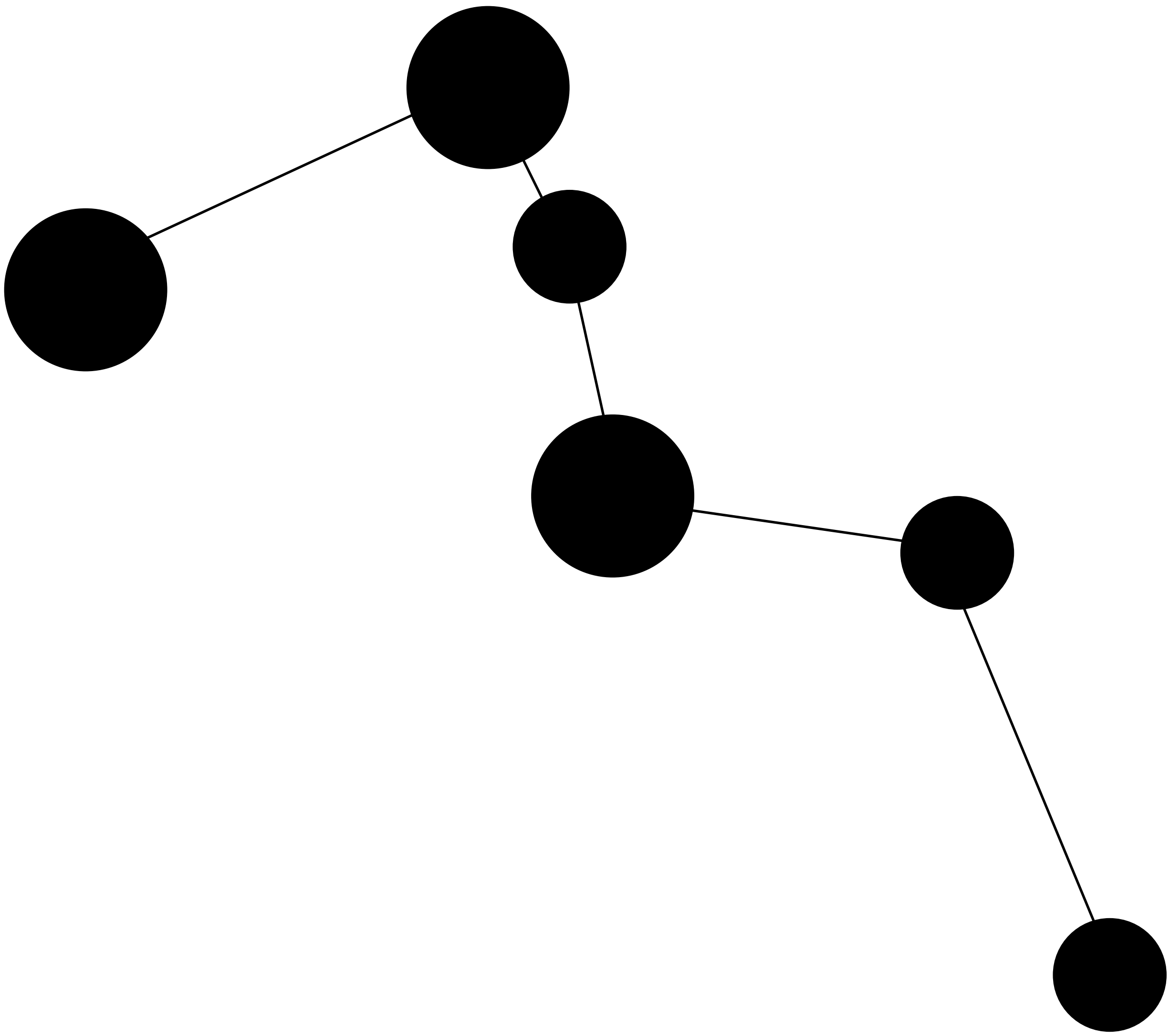
Ursa Major, The Big Bear



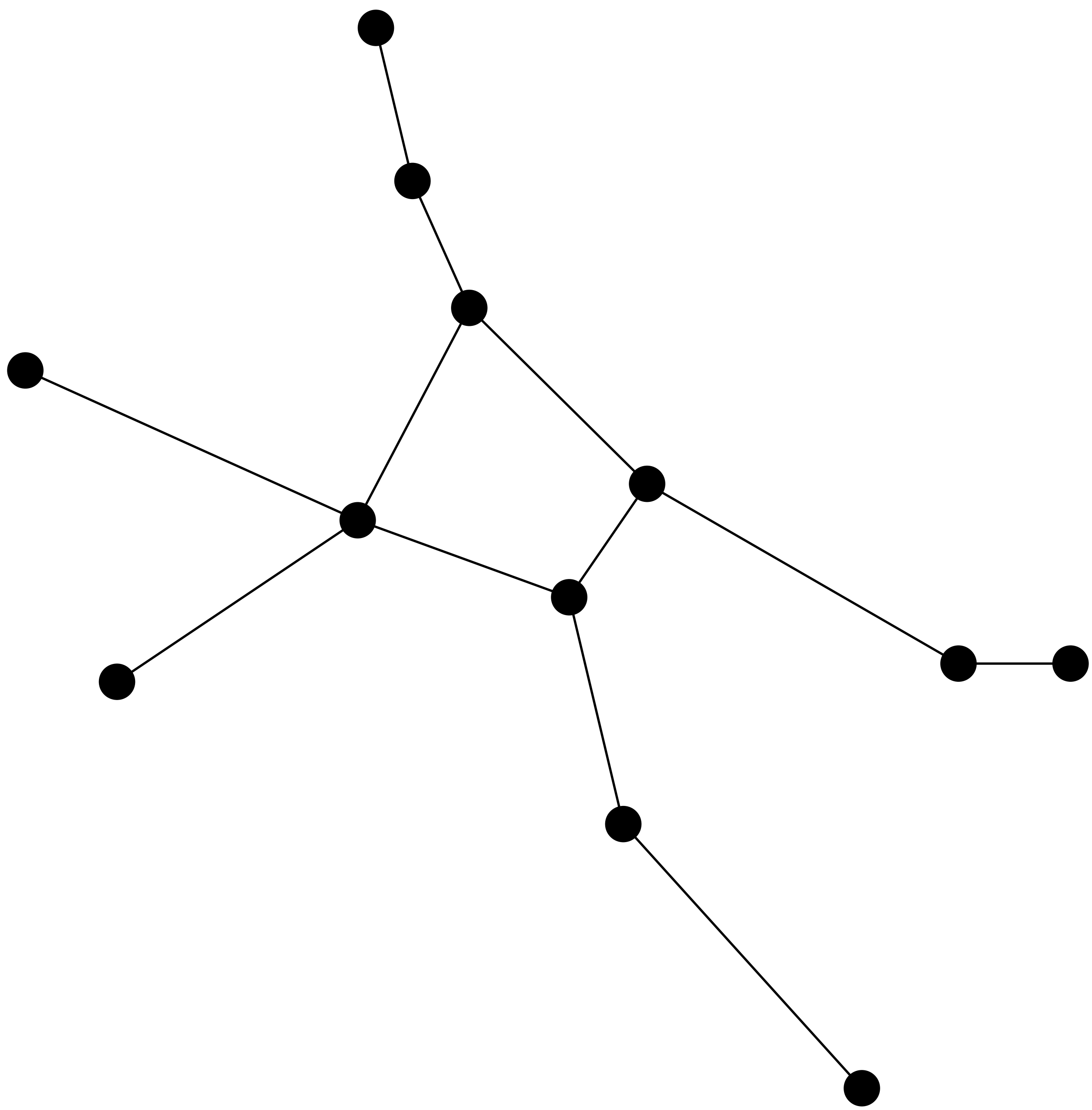
Little Dipper (Ursa Minor, The Little Bear)



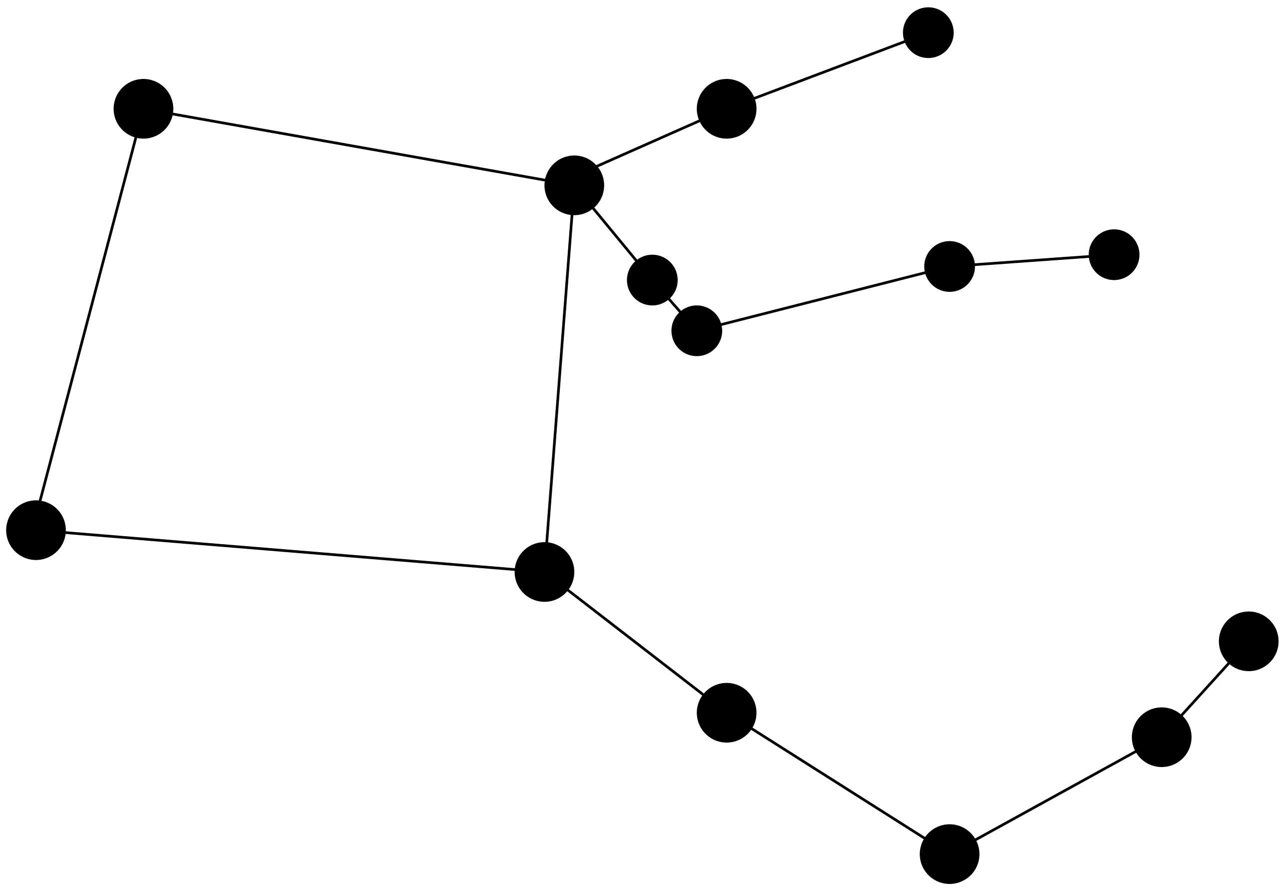
Orion, The Hunter



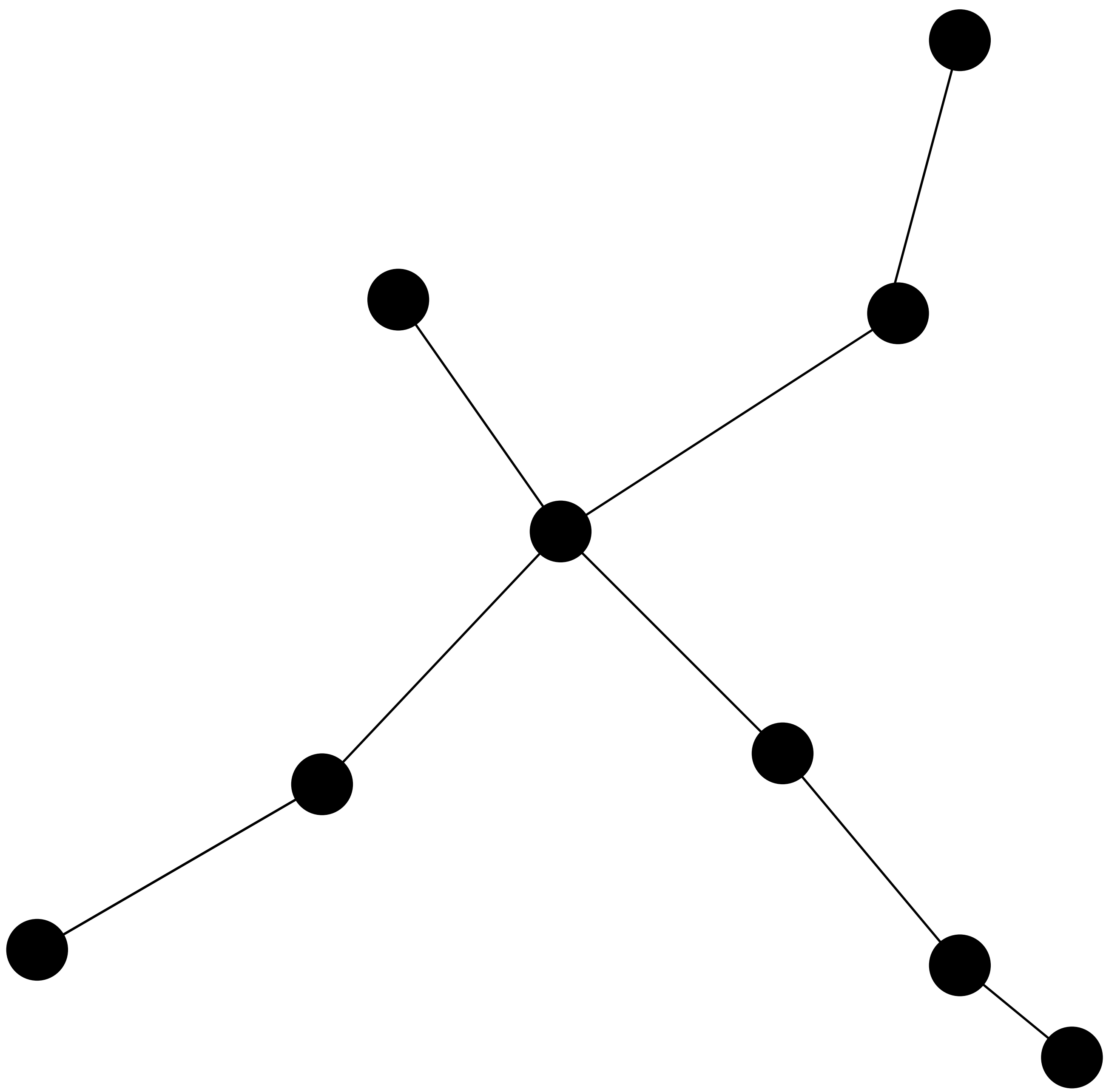
Cassiopeia, The Queen



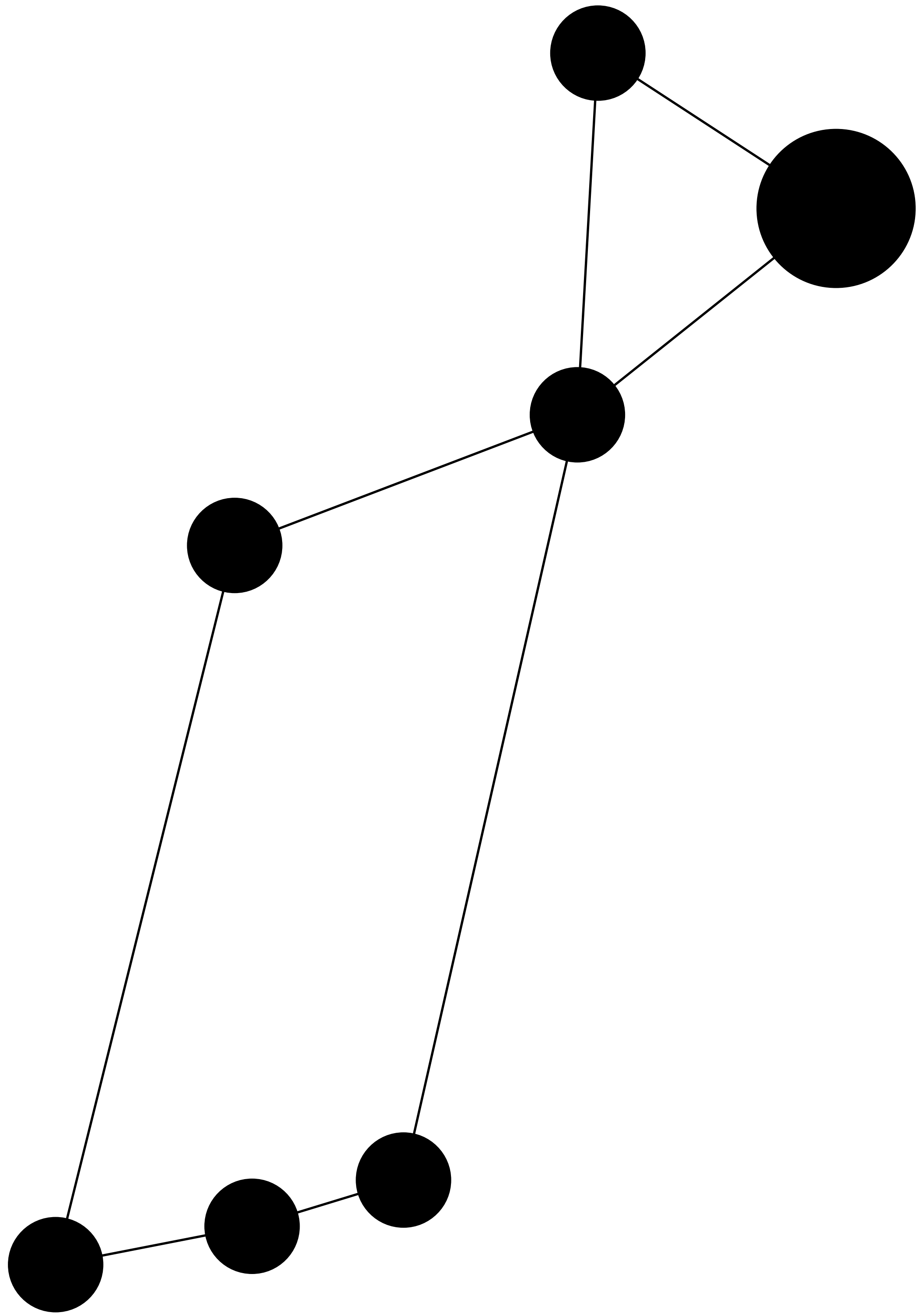
Hercules, The Hero



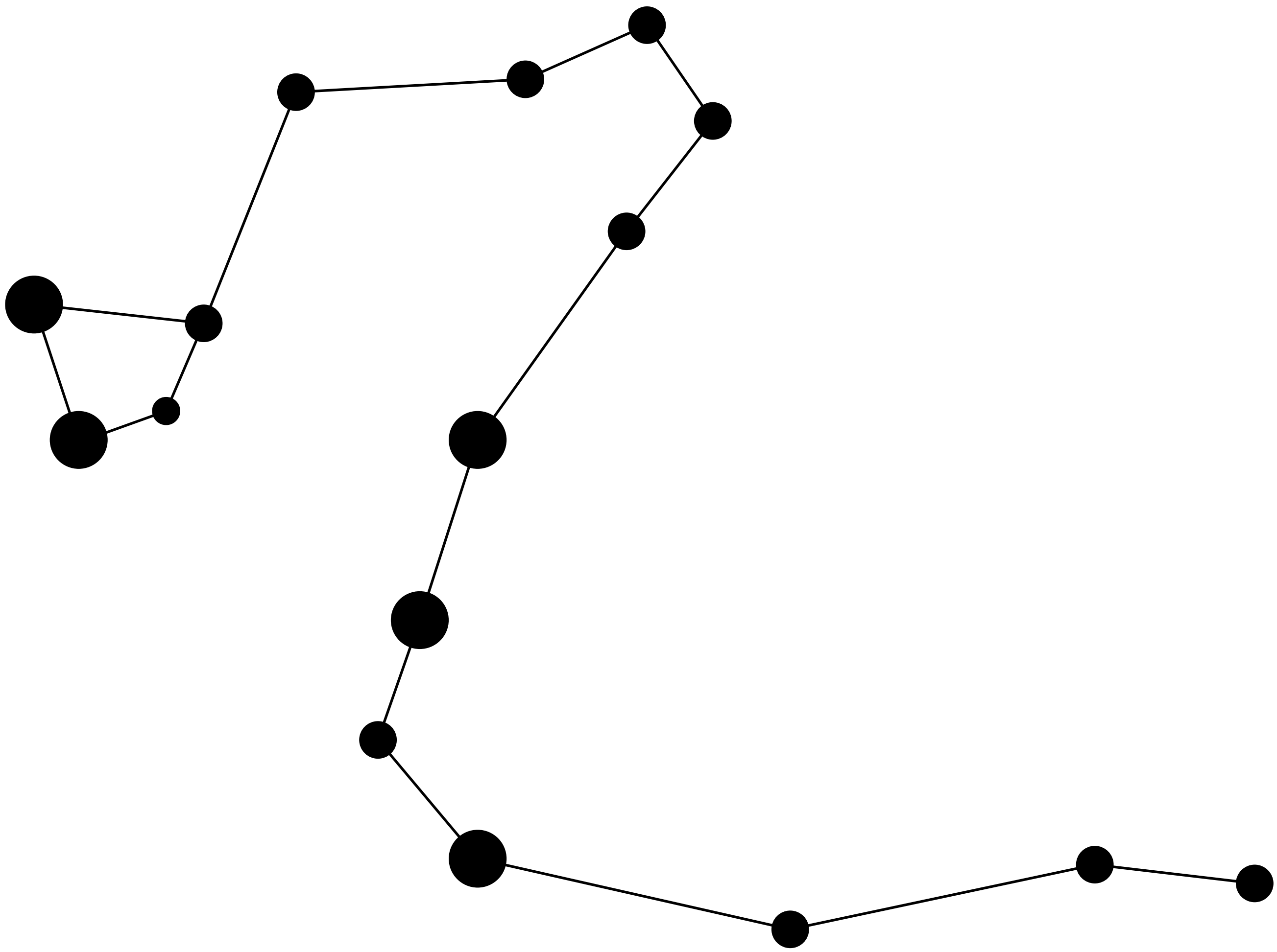
Pegasus, The Winged Horse



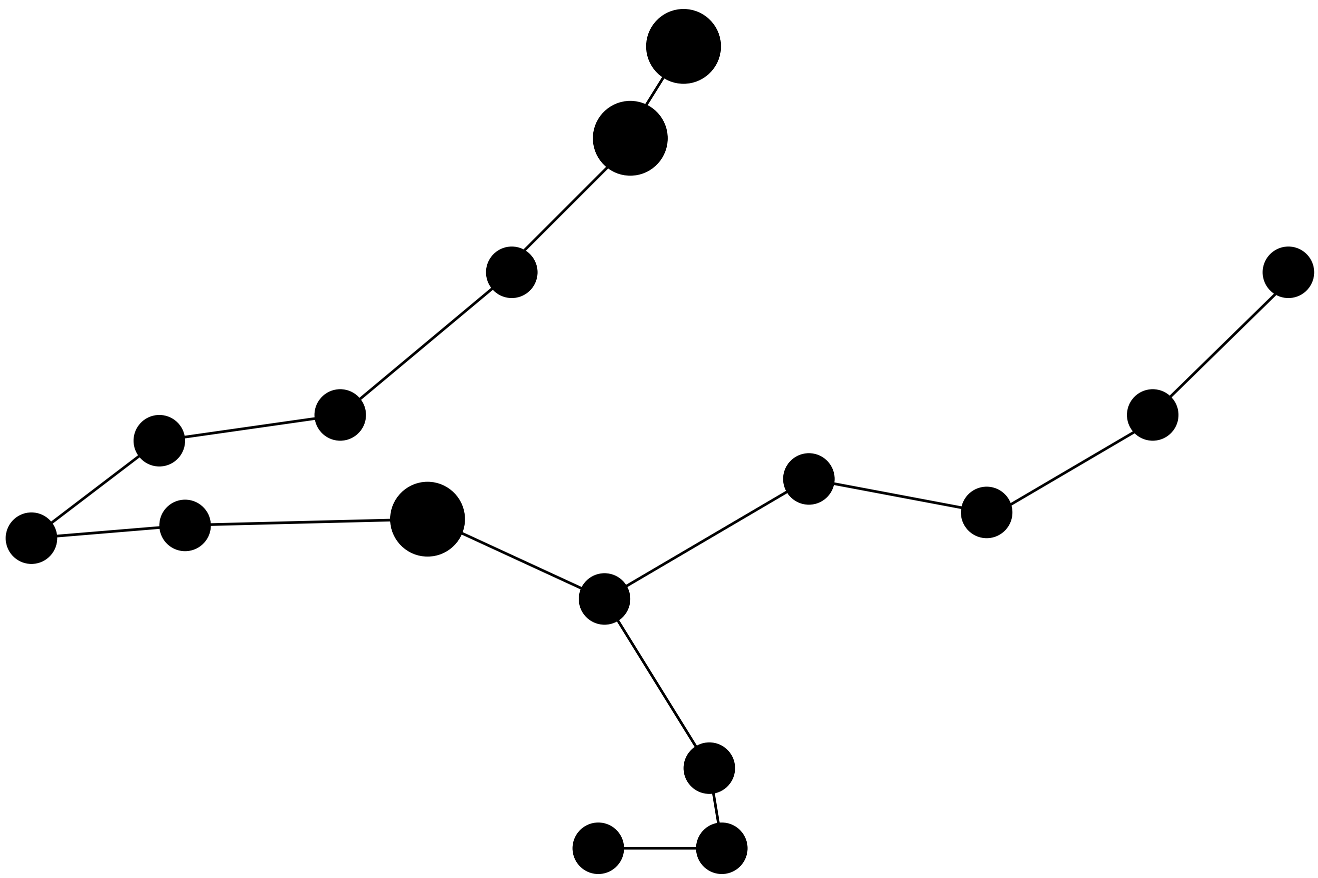
Cygnus, The Swan



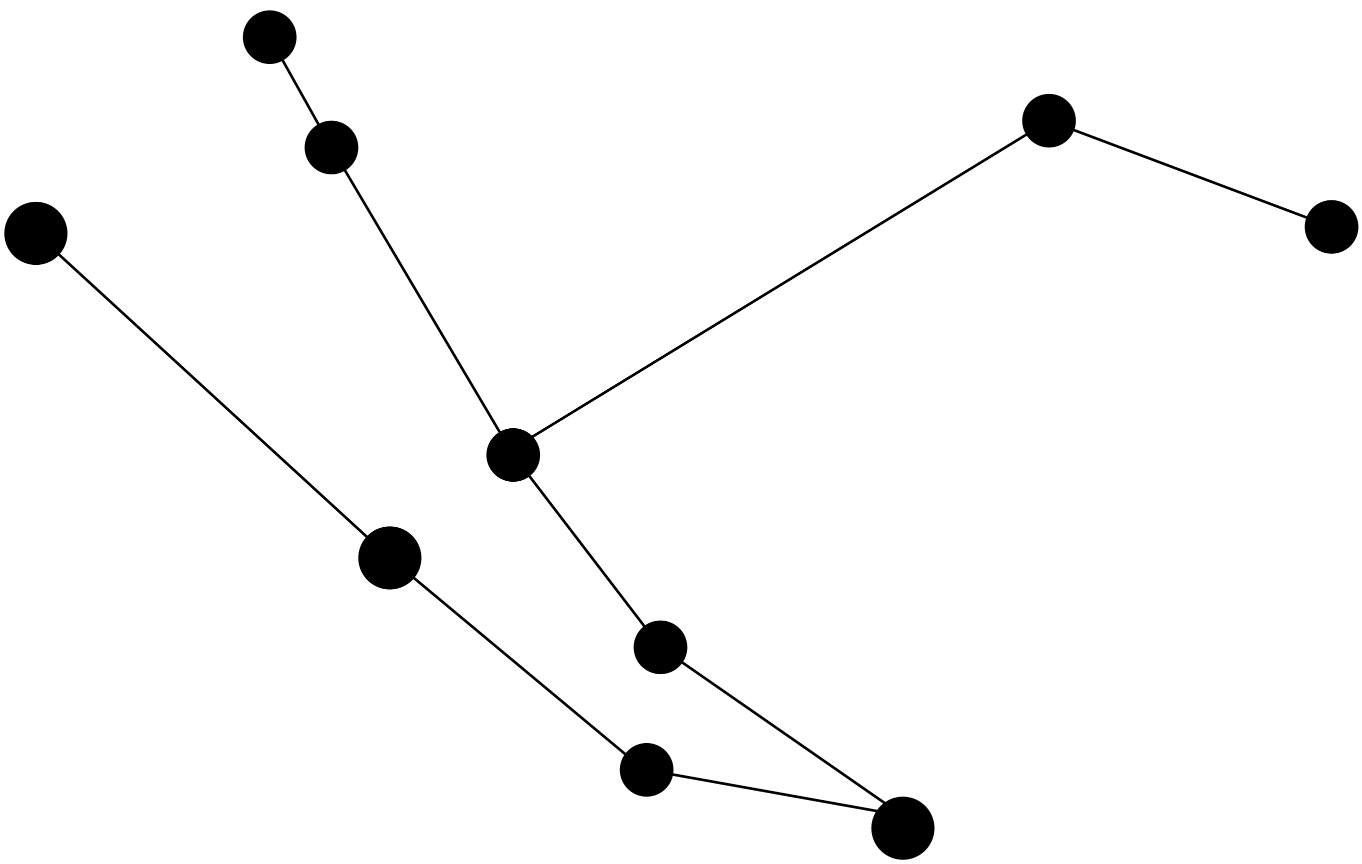
Lyra, The Lyre



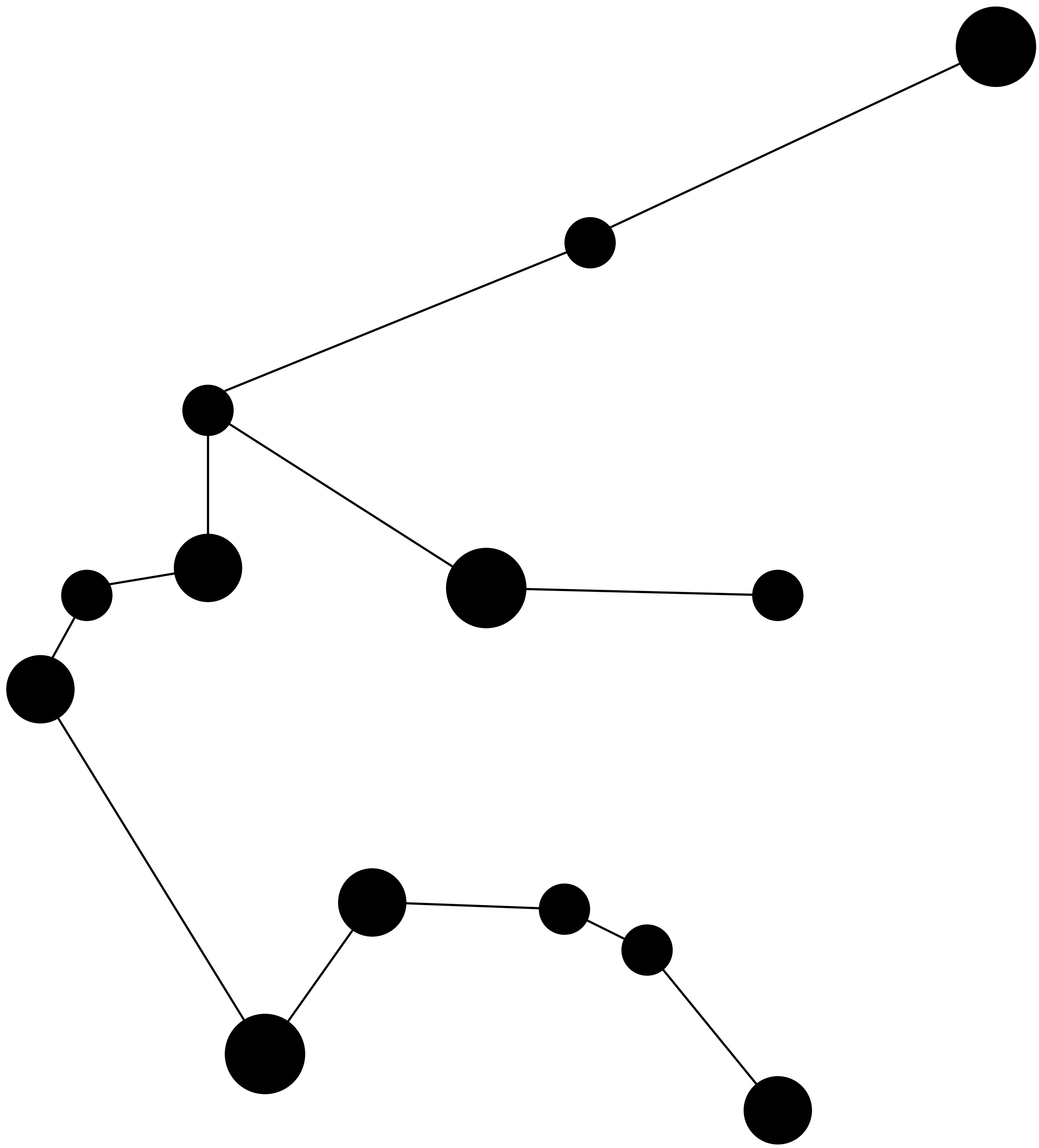
Draco, The Dragon



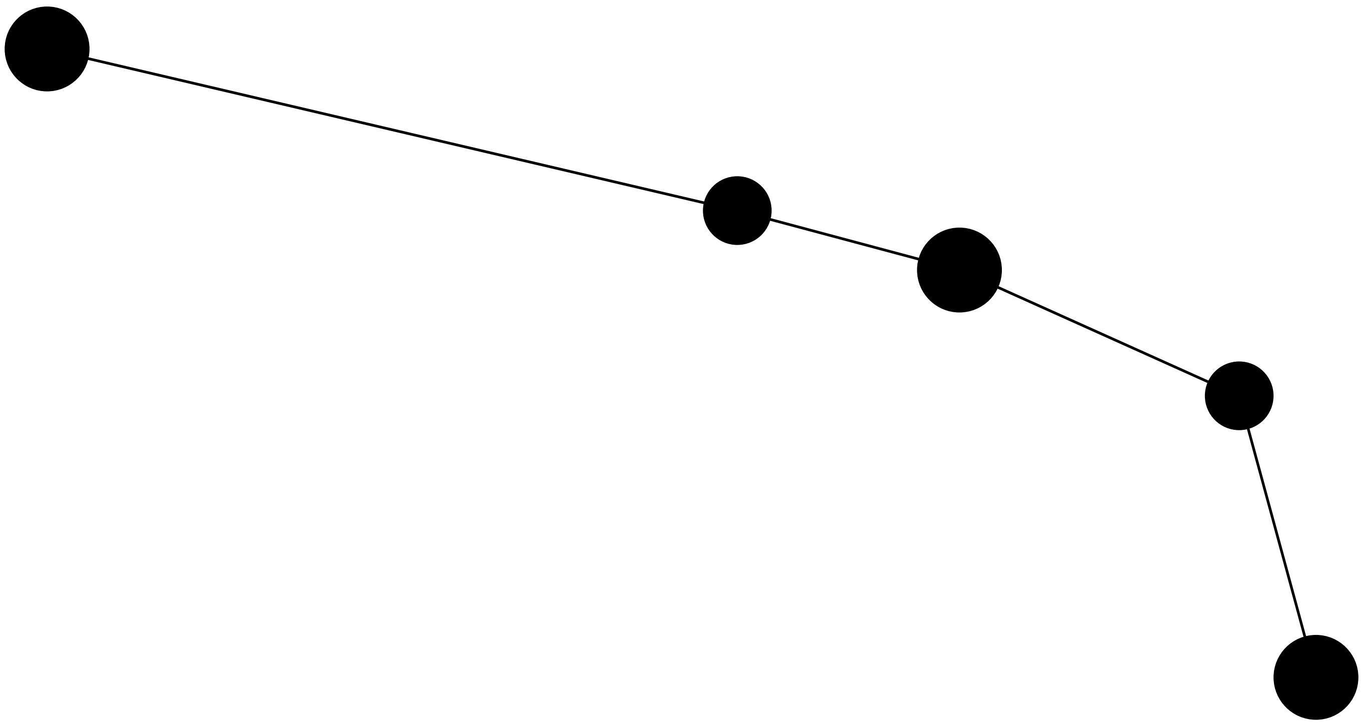
Perseus, The Hero



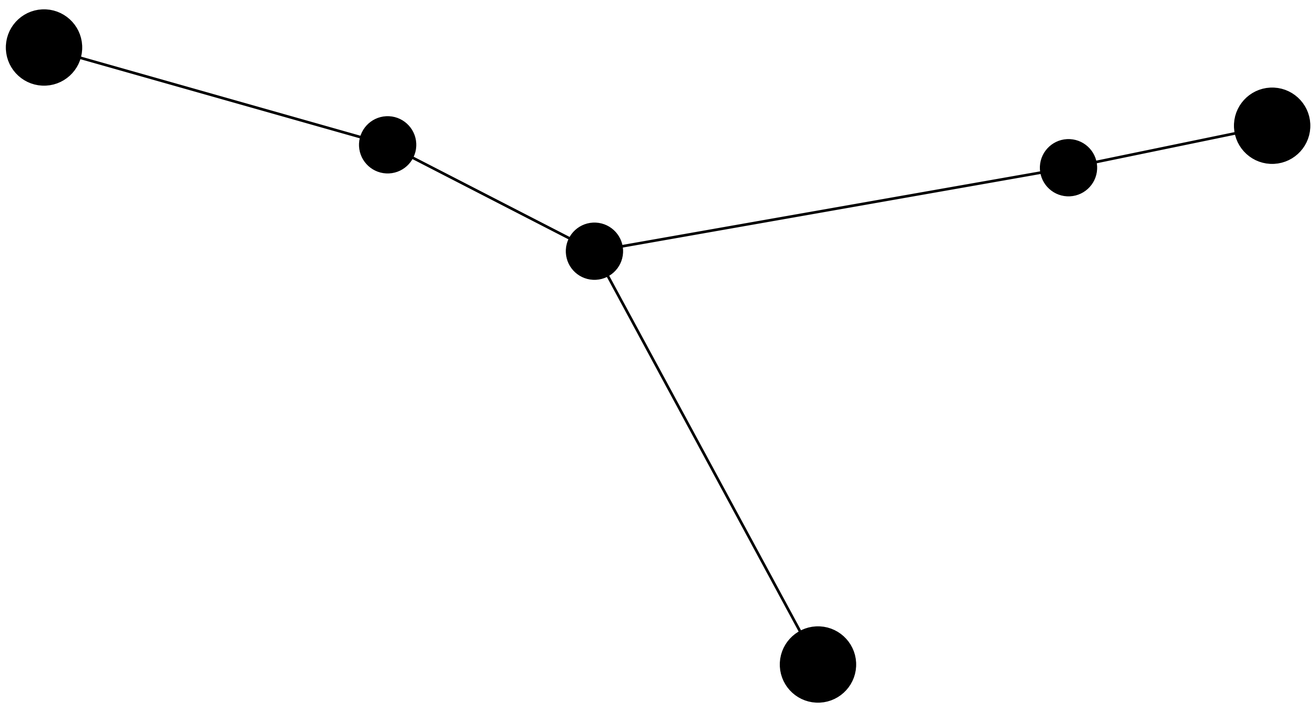
Andromeda, The Princess



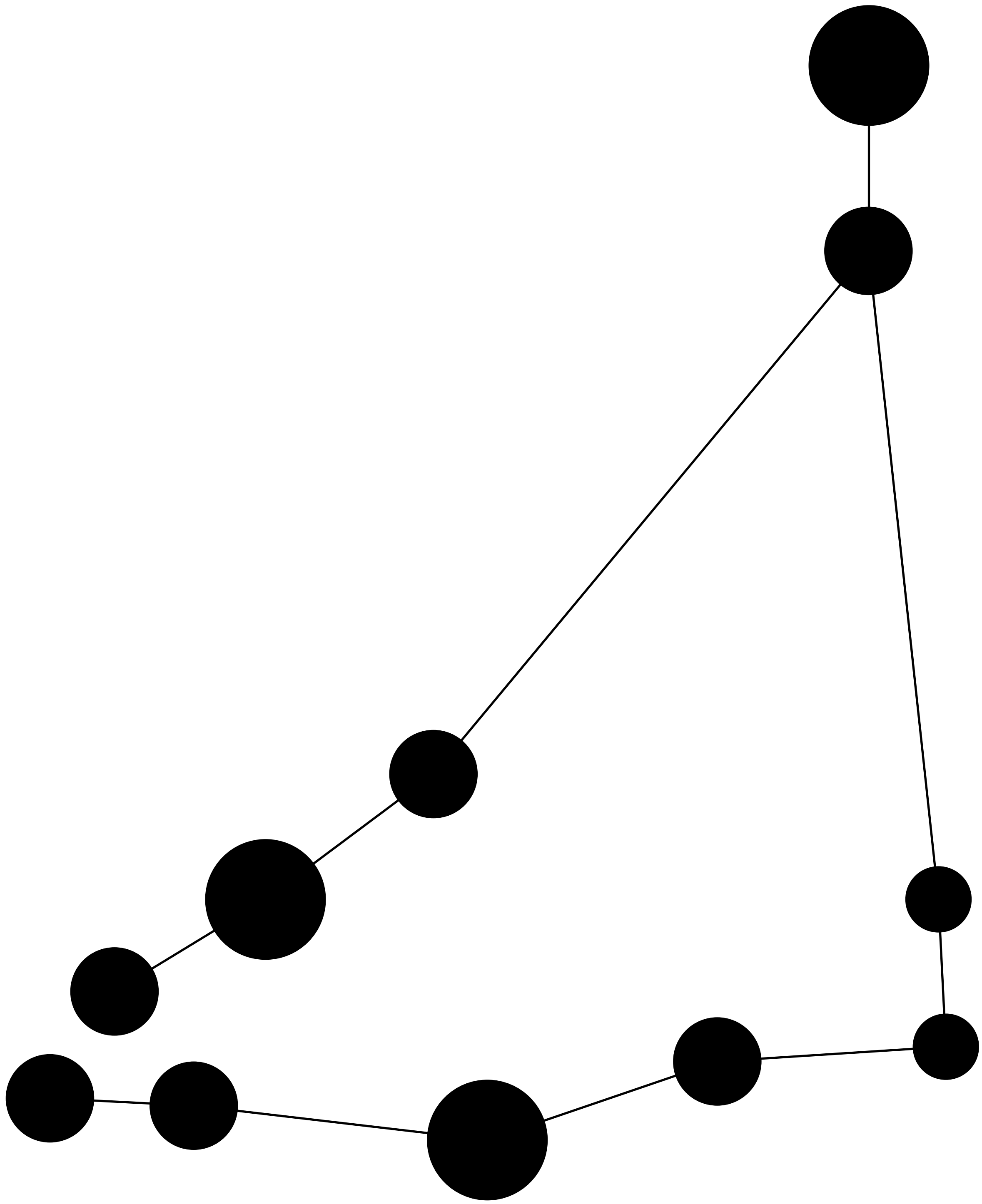
Aquarius, The Water Carrier



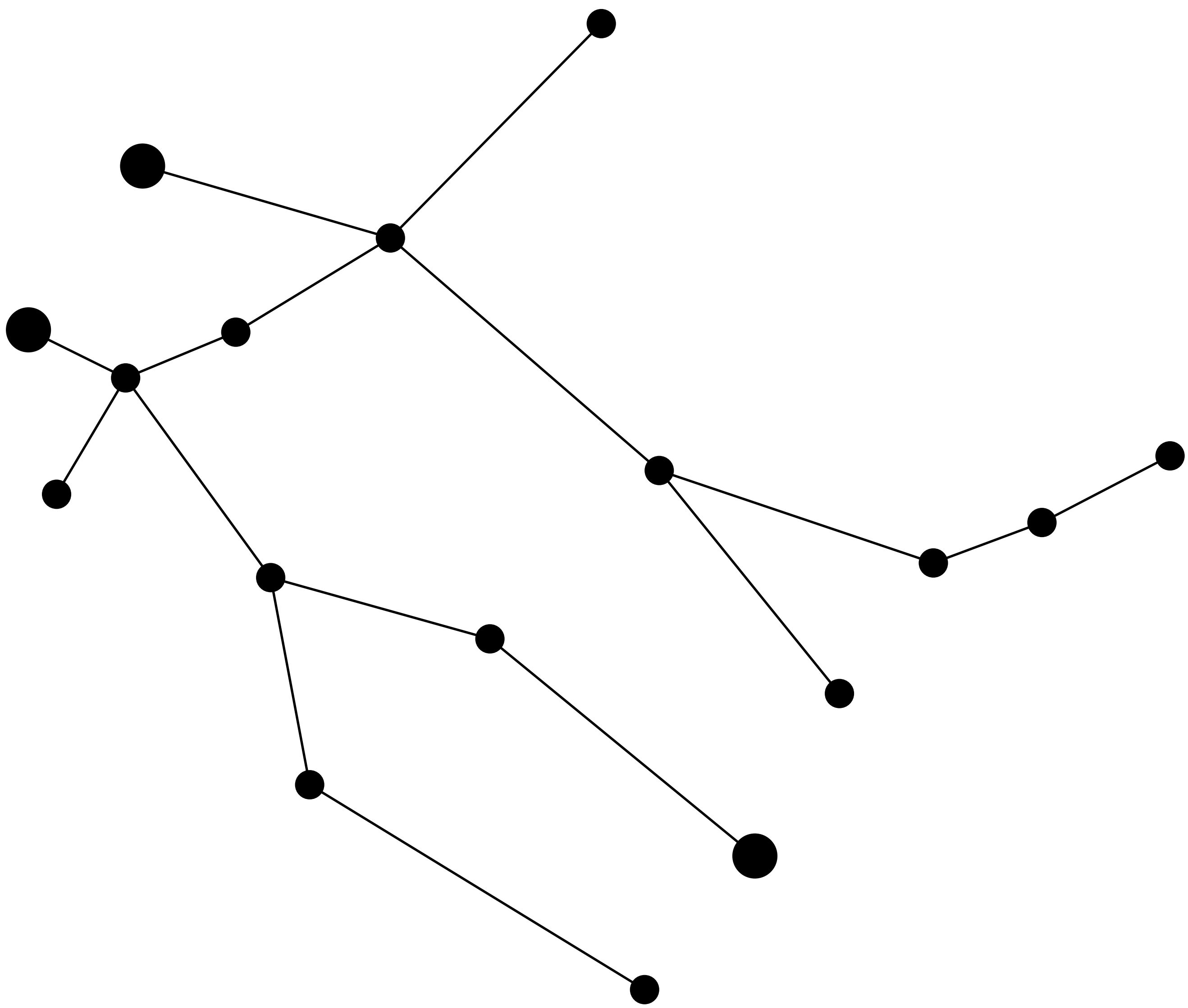
Aries, The Ram



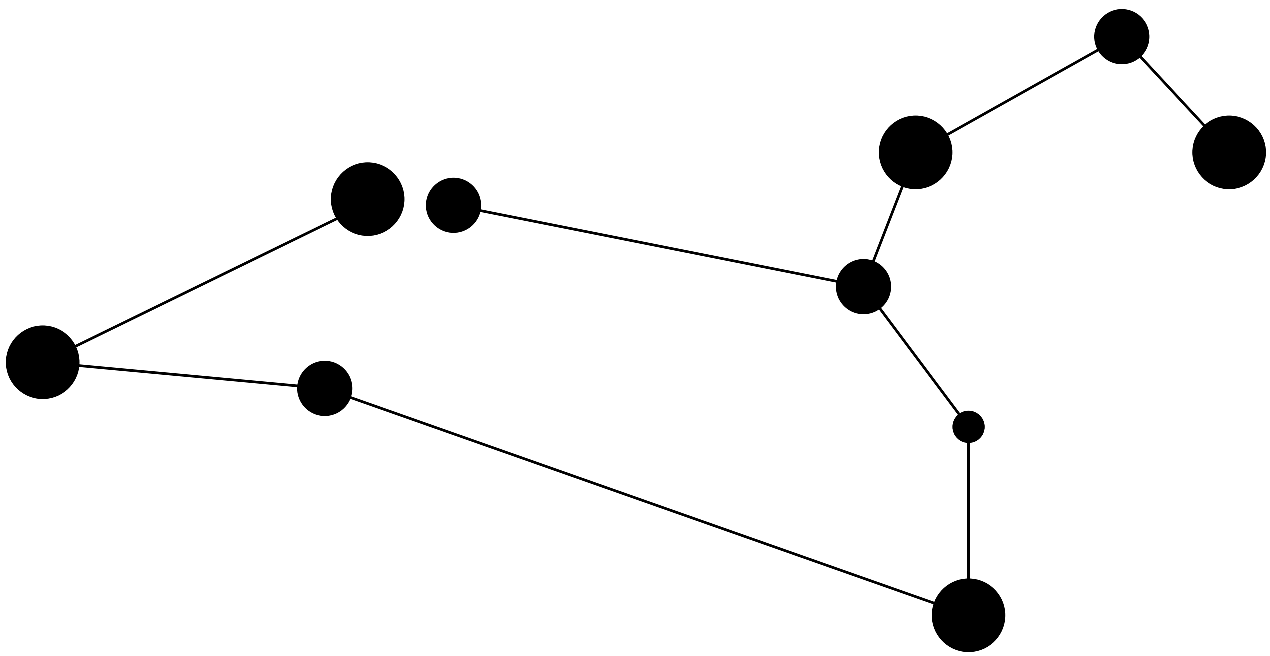
Cancer, The Crab



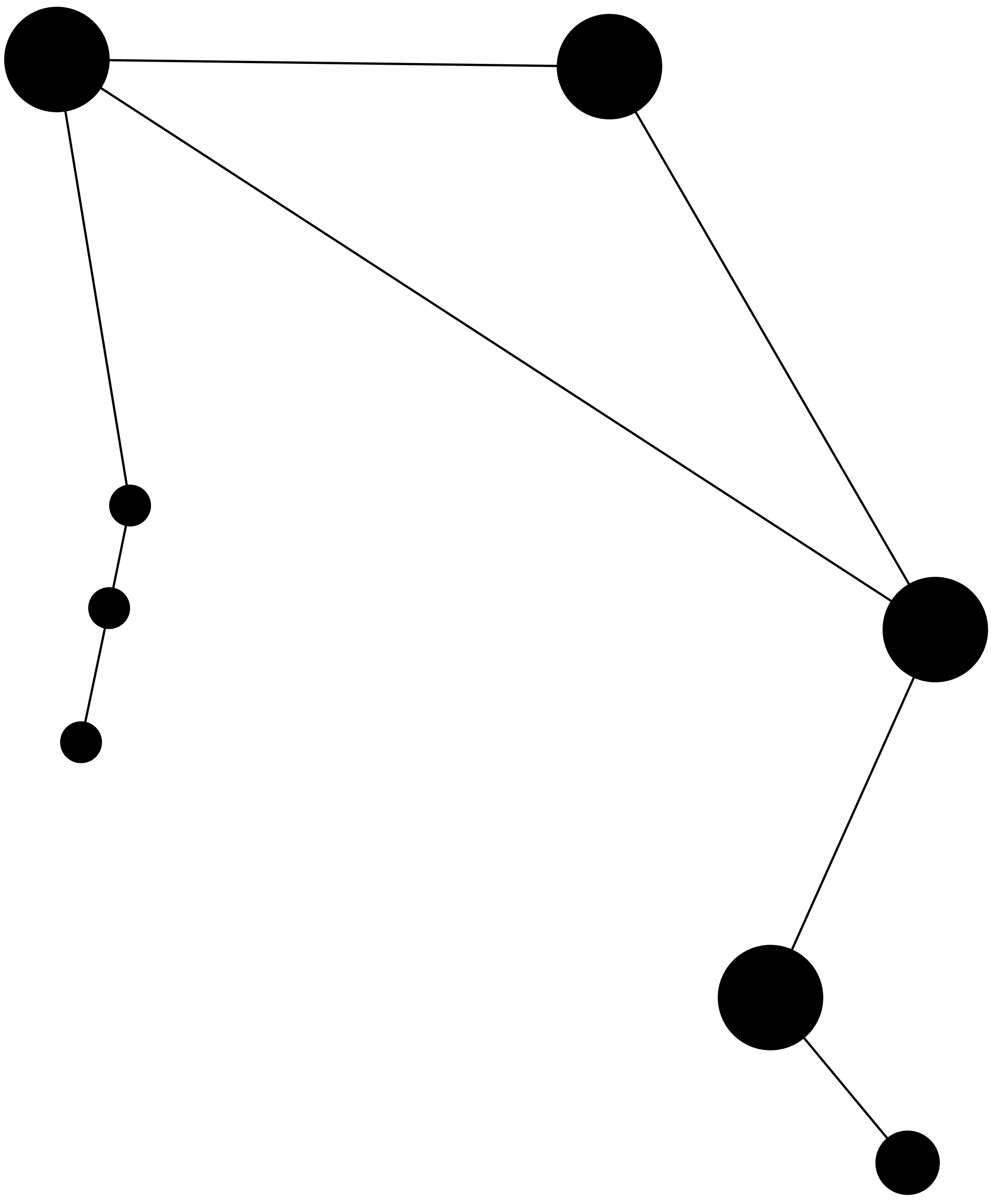
Capricorn, The Goat with the Tail of a Fish



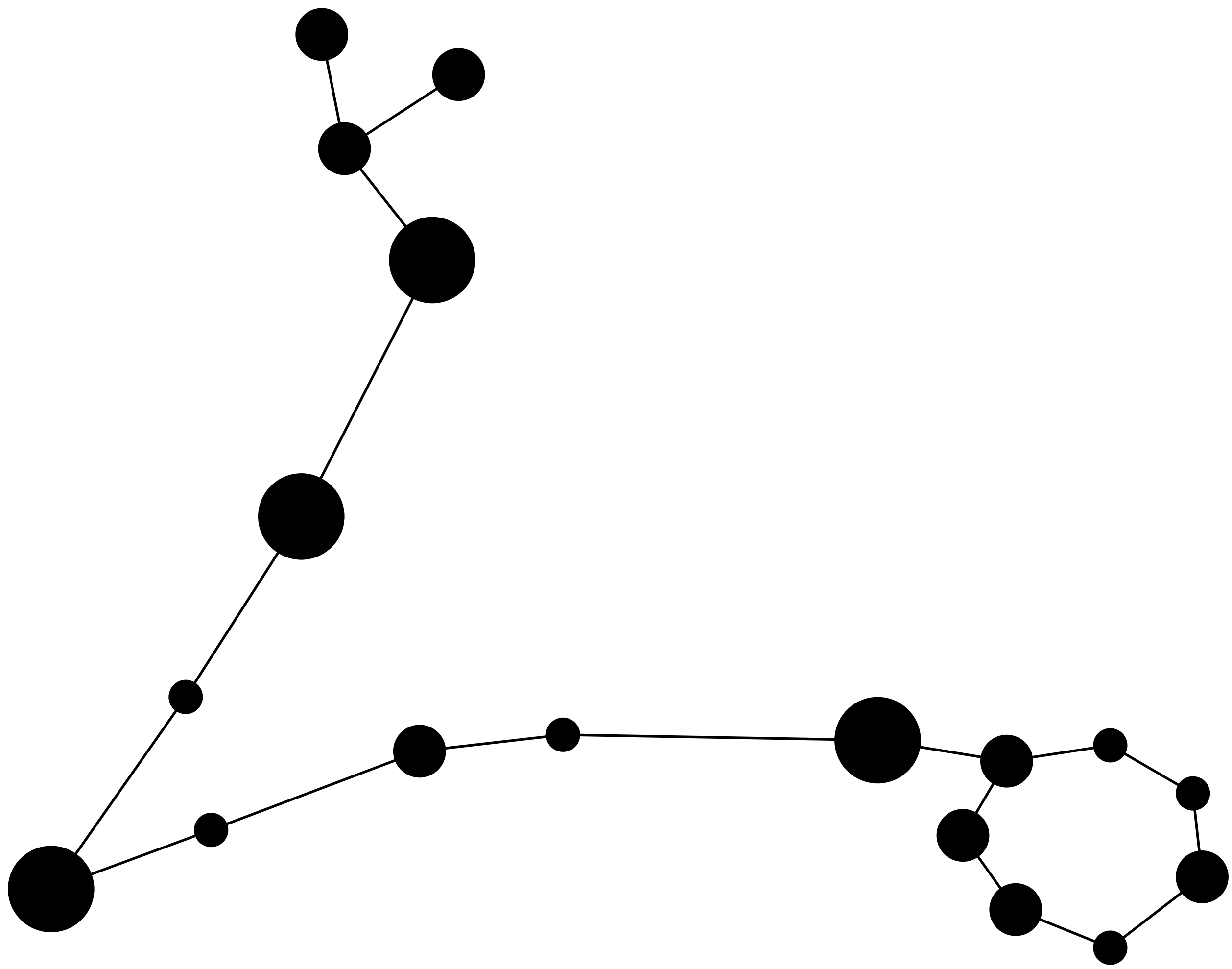
Gemini, The Twins



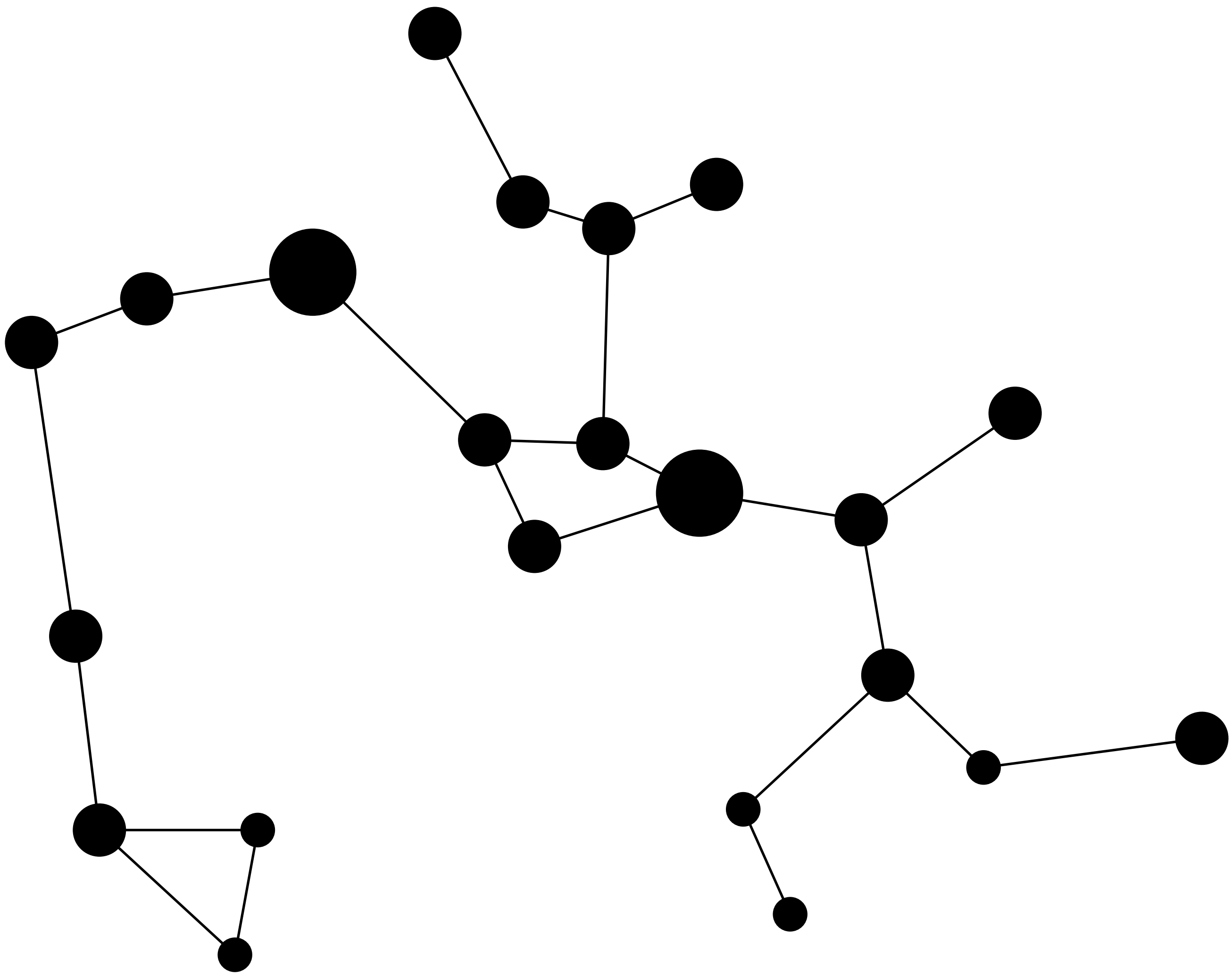
Leo, The Lion



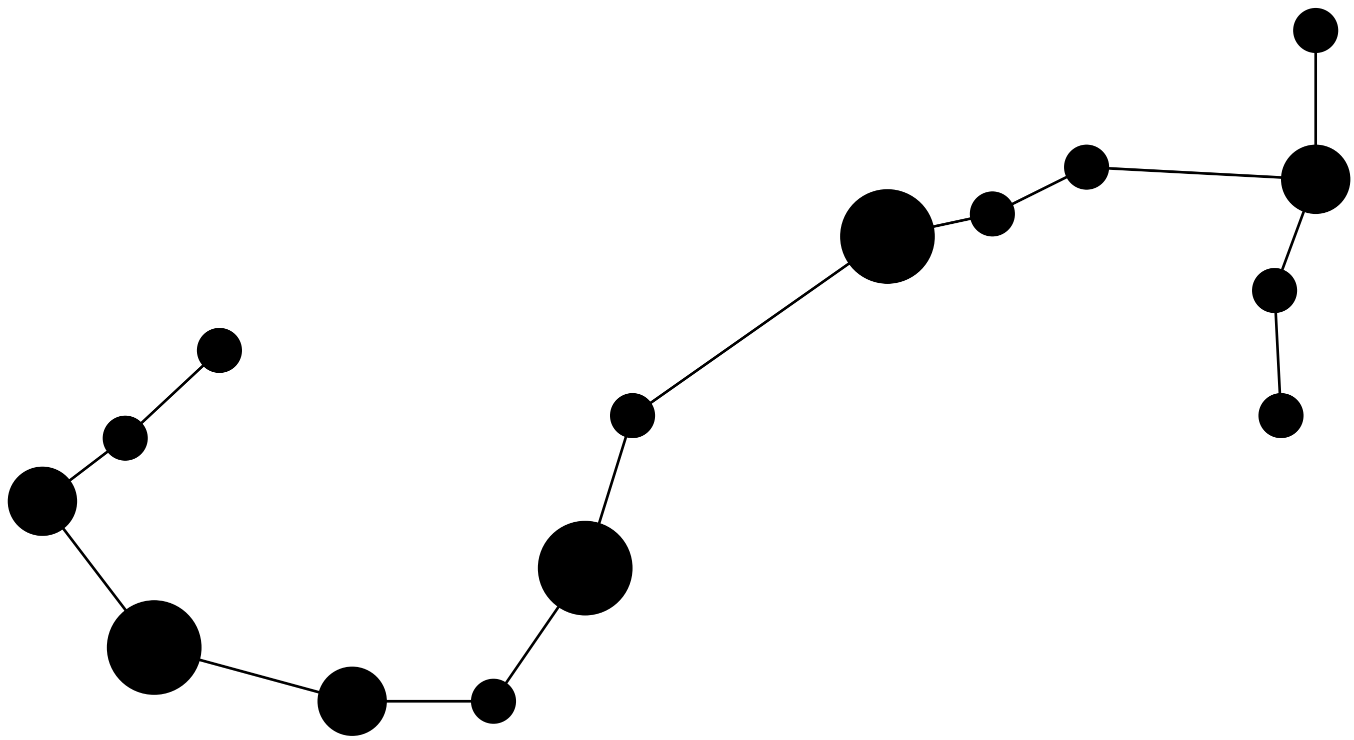
Libra, The Scales



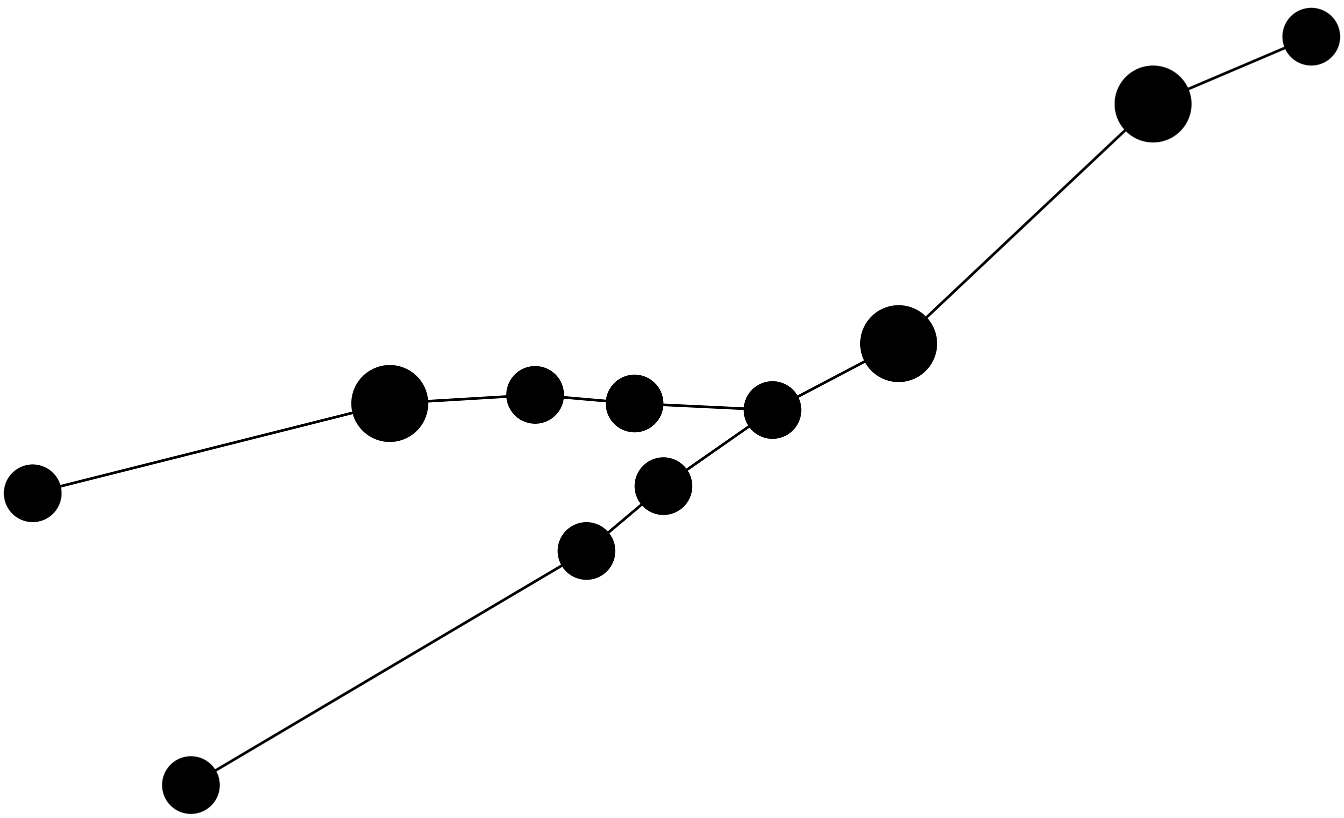
Pisces, The Fish



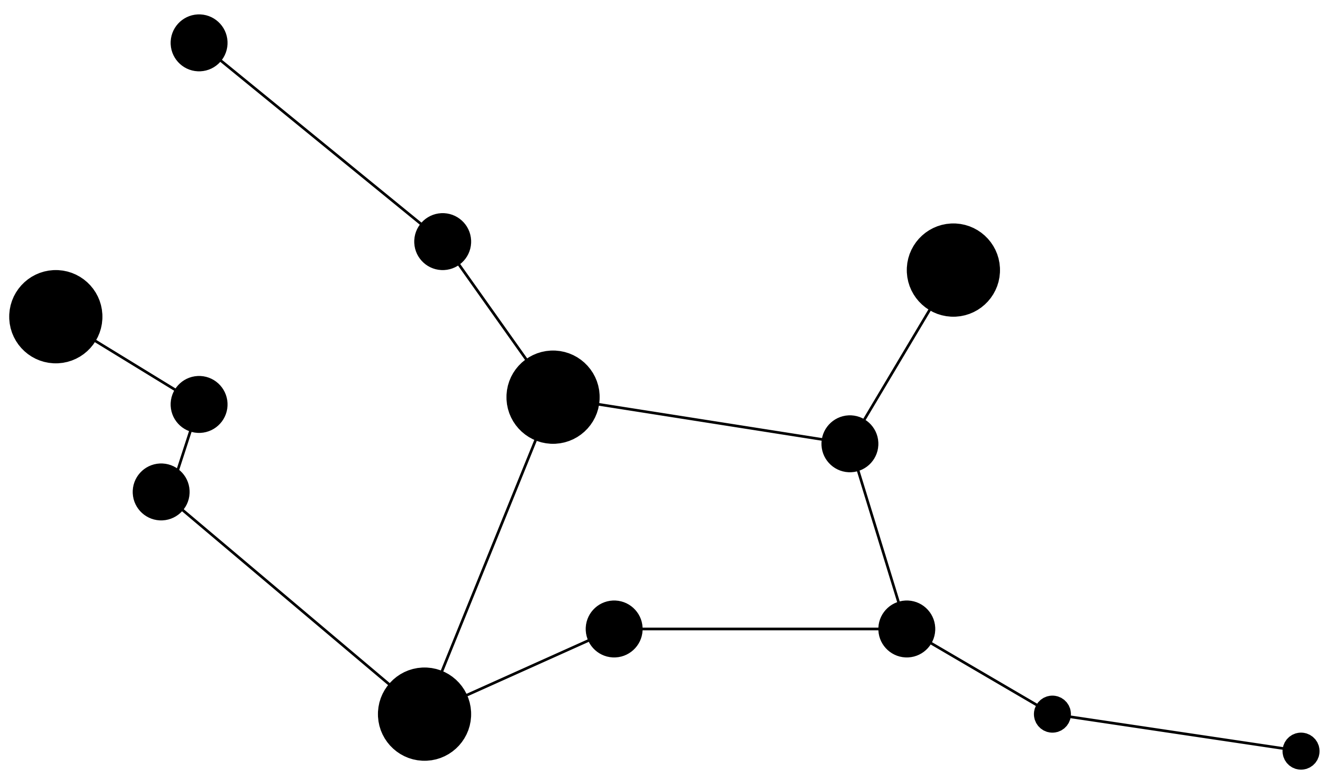
Sagitarius, The Archer



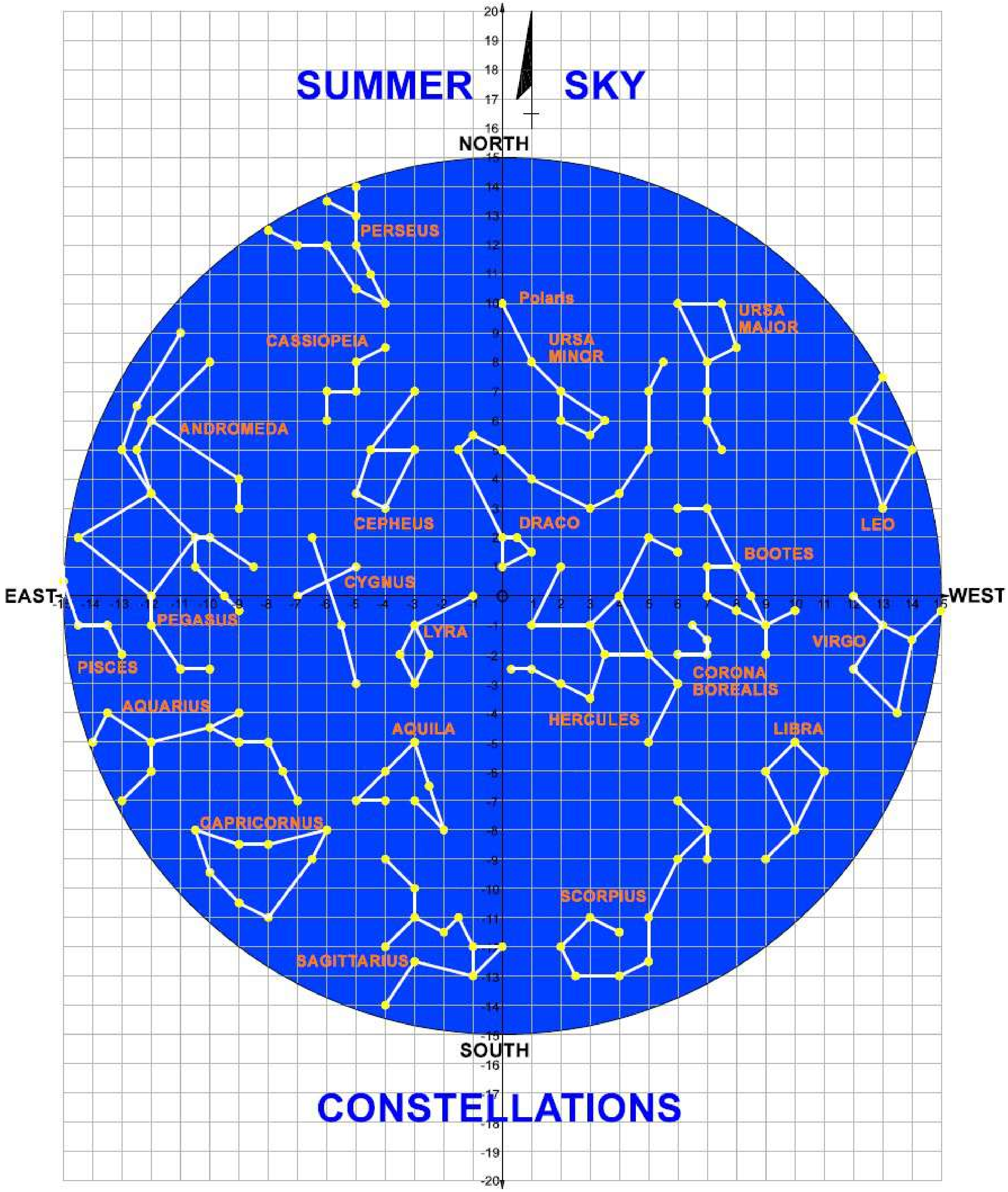
Scorpio, The Scorpion



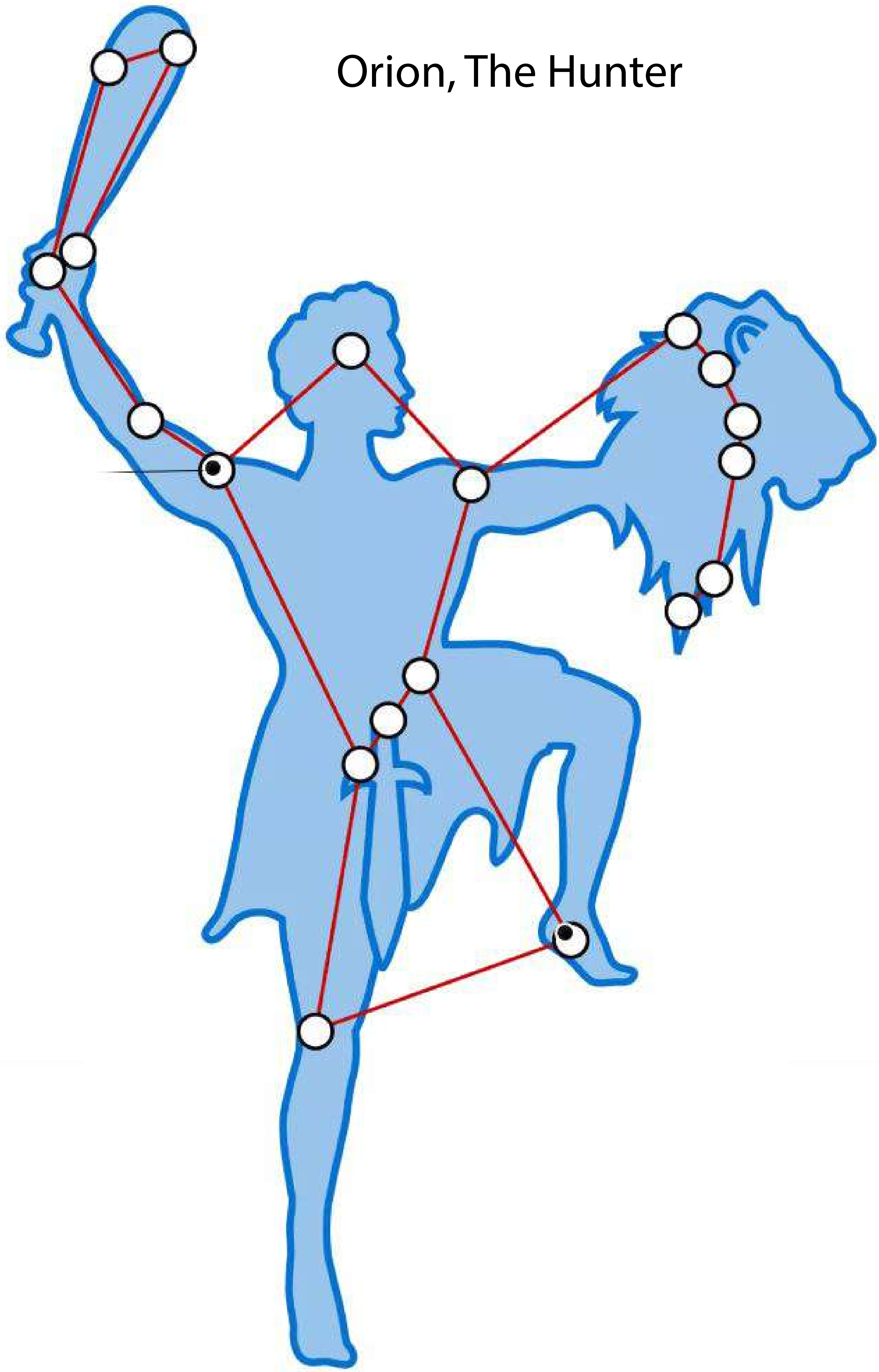
Taurus, The Bull



Virgo, Goddess of Justice

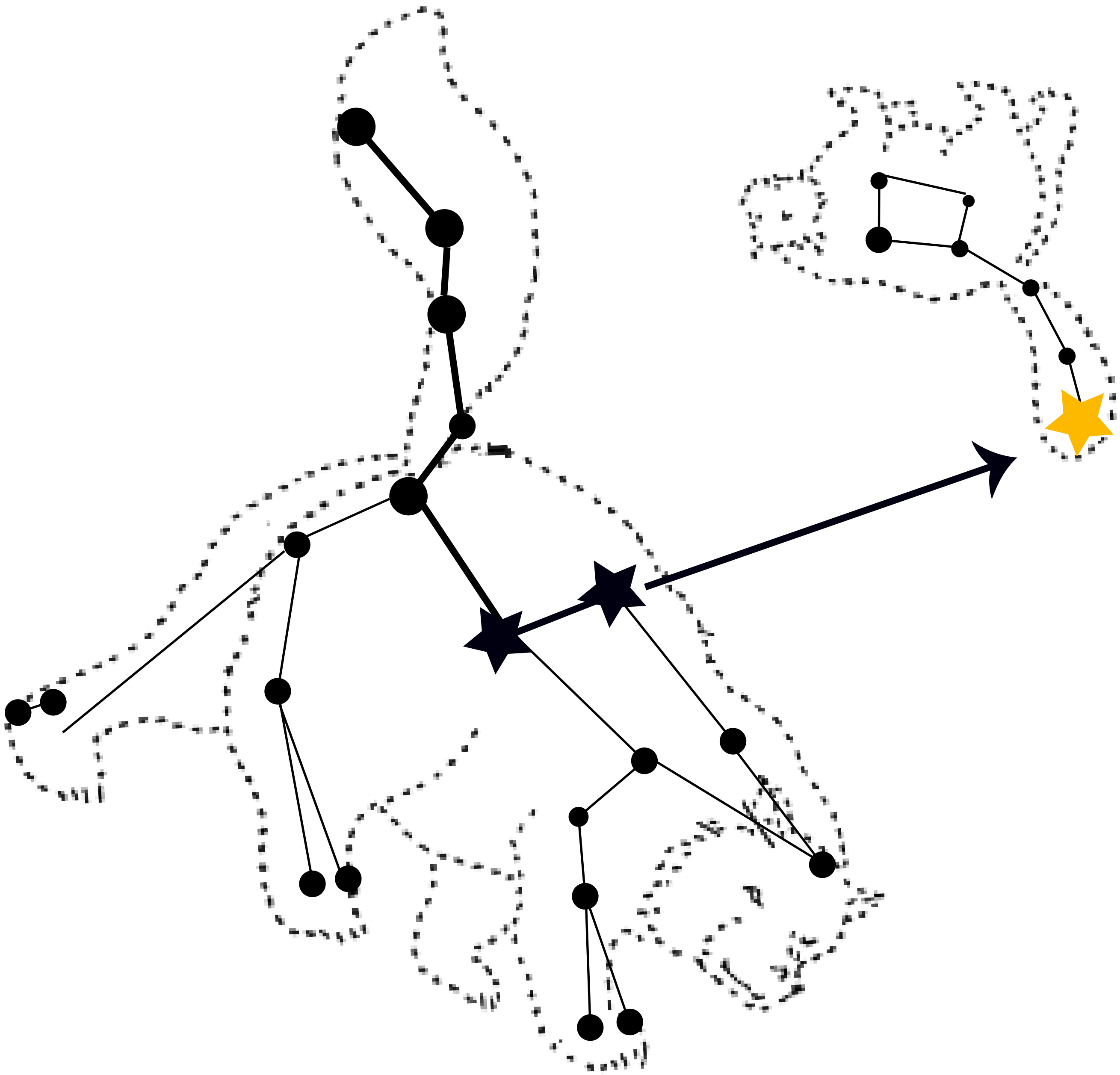

SUMMER SKY
NORTH
SOUTH
EAST
WEST
PERSEUS
Polaris
CASSIOPEIA
URSA MINOR
URSA MAJOR
ANDROMEDA
CEPHEUS
DRACO
LEO
BOOTES
CYGNUS
PEGASUS
LYRA
VIRGO
PISCES
CORONA BOREALIS
AQUARIUS
HERCULES
AQUILA
LIBRA
CAPRICORNUS
SCORPIUS
SAGITTARIUS
CONSTELLATIONS

Orion, The Hunter



How to find Polaris, the North Star

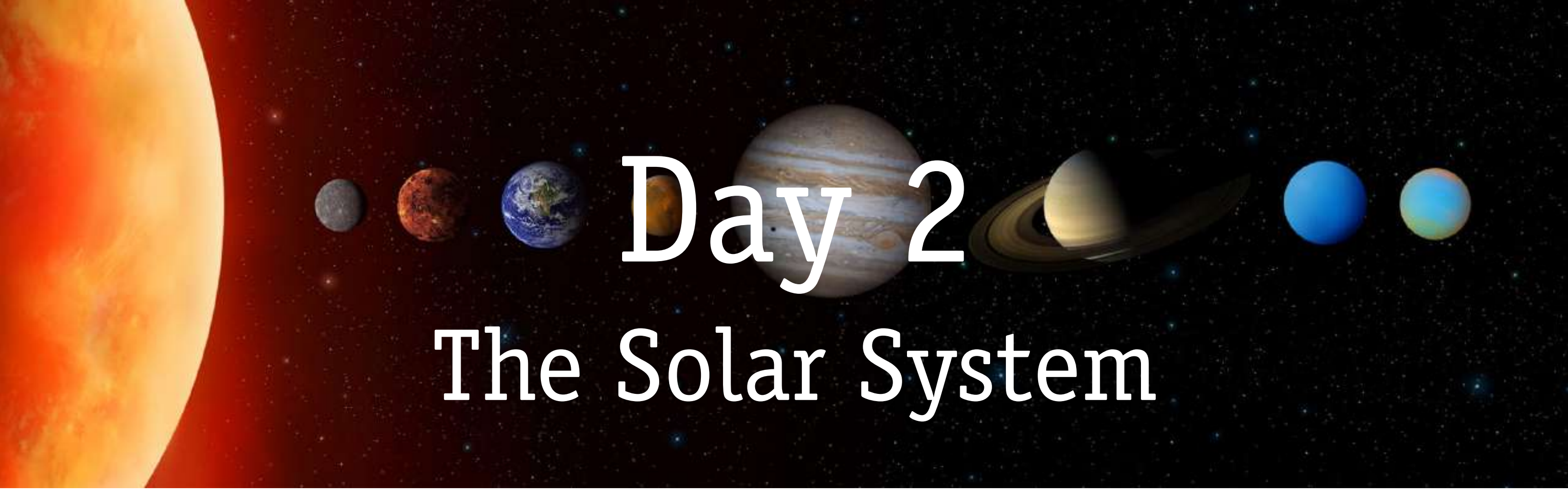
Polaris appears to hold still in our sky, always pointing the way due north



If you can find the Big Dipper, you can find Polaris!
The two outer stars in the bowl of the Big Dipper always point to Polaris, the end of the handle of the Little Dipper.

Day 2

The Solar System



Day 2

The Solar System

Introduction

The solar system is our **Sun** and *everything* that travels around it. There are **planets**, **moons**, **comets**, **asteroids,** and even dust and gas. All these objects travelling around the Sun are held in the Sun's **gravity**, making the Sun the center of the solar system. Even though the distances between the Sun and the planets are enormous, gravity is great enough to hold the planets in **orbit** around the Sun.

Questions to guide explorations and experiments

- What is the solar system?
- What is a planet? What planets are in the solar system?
- Why do the Earth and other planets revolve around (orbit) the Sun?
- What else revolves around the Sun?
- How big is the solar system? How big are all the planets?

Books and activities

- **Books:** fiction, nonfiction and poetry all about our solar system
- **Activities:** explore the size of the planets in our solar system and how far they are from the Sun

Children's Books

Fiction

- *The Lizard and the Sun / La Lagartija y el Sol* by Alma Flor Ada (Ages 4-8)
- *Pluto Is Peeved: An Ex-Planet Searches for Answers* by Jacqueline Jules (Ages 6-9)
- *Miss Tracy Is Spacey!* by Dan Gutman (Ages 6-9)
- *Stink: Solar System Superhero* by Megan McDonald (Ages 4-8)
- *Zathura* by Chris Van Allsburg (Ages 4-8)

Poetry

- *Comets, Stars, the Moon, and Mars: Space Poems and Paintings* by Douglas Florian (Ages 6-9)
- *The Day the Universe Exploded My Head* by Allan Wolf (Ages 9-12)

Biography

- *Caroline's Comets: A True Story* by Emily Arnold McCully (Ages 6-9)
- *Nicolaus Copernicus: The Earth Is a Planet* by Dennis Fradin (Ages 9-12)
- *Galileo's Universe* by J. Patrick Lewis (Ages 9-12)
- *I, Galileo* by Bonnie Christensen (Ages 6-9)
- *The Librarian Who Measured the Earth* by Kathryn Lasky (Ages 9-12)
- *The Planet Hunter: The Story Behind What Happened to Pluto* by Elizabeth Rusch (Ages 4-8)
- *Starry Messenger: Galileo Galilei* by Peter Sis (Ages 6-9)

Nonfiction

- *Comets, Meteors, and Asteroids: Voyagers of the Solar System* by Ellen Lawrence (Ages 6-9)
- *Exploring Our Solar System* by Sally Ride and Tam O'Shaughnessy (Ages 9-12)
- *Gravity* by Jason Chin (Ages 6-9)
- *Little Kids' First Big Book of Space* by National Geographic Kids (Ages 4-8)
- *The Magic School Bus Lost in the Solar System* by Joanna Cole (Ages 6-9)
- *Magic School Bus Presents: Our Solar System* by Tom Jackson (Ages 6-9)

Children's Books

Nonfiction

- *Me and My Place in Space* by Joan Sweeney (Ages 4-8)
- *Our Solar System* by Seymour Simon (Ages 6-9)
- *The Planets* by Gail Gibbons (Ages 6-9)
- *The Planets in Our Solar System* by Franklyn Branley (Ages 4-8)
- *Professor Astro Cat's Solar System* by Dr. Dominic Walliman (Ages 6-9)
- *Science Comics: Solar System: Our Place in Space* by Rosemary Mosco (Ages 9-12)
- *The Sun Is Kind of a Big Deal* by Nick Seluk (Ages 4-8)
- *The Sun: Our Nearest Star* by Franklyn Branley (Ages 4-8)
- *What Makes Day and Night?* by Franklyn Branley (Ages 4-8)

Online fact sheets

Small Worlds, Big Discoveries! by NASA

https://spaceplace.nasa.gov/review/posters/small-bodies/small-bodies-factsheet.pdf

Asteroids: Space Rocks with a Story by NASA (also available in Spanish)

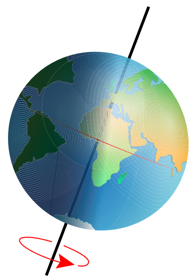
https://spaceplace.nasa.gov/review/posters/stardust/asteroids_fun_sheet.pdf

https://spaceplace.nasa.gov/review/posters/stardust/asteroids_fun_sheet_spanish.pdf

Space Words

Asteroid
A rocky space object that can be a few feet wide to several hundred miles wide. Most asteroids in our solar system orbit in a belt between Mars and Jupiter.

Axis
An imaginary line that goes through a planet's center from top to bottom. A planet spins (rotates) around its own axis.



Comet
A frozen mass of gas and dust that orbits the Sun and may form a long, bright tail when it is flying close to the Sun.

Dwarf planet
A non-satellite body that is in orbit around the Sun, has sufficient mass to have a nearly round shape, but is not the dominant body in its orbit.

Elliptical orbit
The oval (not round) pattern that describes how the planets in our solar system move around the Sun.

Gravity
A force that pulls matter together; a force that pulls people and objects toward the ground.

Moon
A natural satellite that orbits a larger object. Earth has one Moon, the one we see in the night sky.

Orbit
The curved path followed by an object in space as it goes around another object; to travel around another object in a single path.

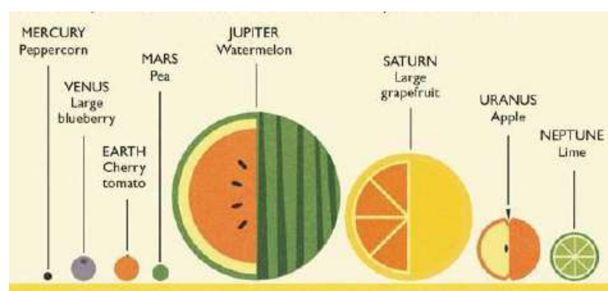
Planet
A celestial body that (1) is in orbit around the Sun, (2) has sufficient mass to have a nearly round shape, and (3) it is the dominant body in its orbit.

Revolve
To move in an orbit or circle around a fixed point. The Earth revolves around the Sun.

Rotate
To turn around a center point—or axis, like a wheel turns on a bicycle. The Earth rotates from day to night.

Satellite
An object that orbits another object. A moon is a natural satellite.

Scale
Scale is the implied relationship (or ratio) between a model and the actual object. A scale model is a representation of an object that is larger or smaller than the actual size of the object being represented.



Solar system
The Sun and all of the planets, comets, asteroids, and other space bodies that revolve around it.

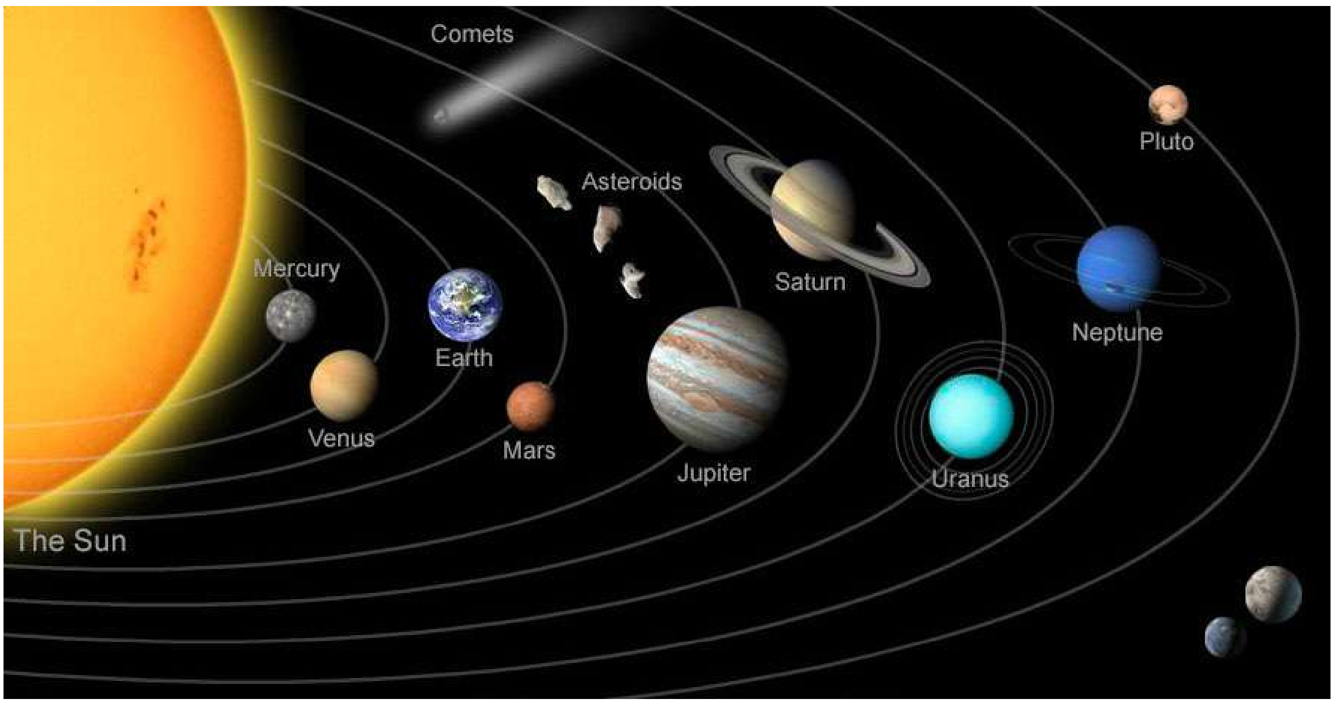
Star
A giant ball of hot gas that emits light and energy created through nuclear fusion at its core.

Sun
The star in the center of our solar system. Like all stars, the Sun is composed of a great burning ball of gases. It is made of 92.1% hydrogen and 7.8% helium.

Activity 1: Solar System Model (Distance)

Introduction

Our **solar system** is the **Sun** and everything that travels around it. Traveling around the Sun are eight official **planets**, at least five **dwarf planets**, nearly 200 **moons** (or natural satellites of the planets), and a large number of **comets** and **asteroids**.



Supplies

- Tape measure
- Rolls of toilet paper
- Index cards or paper
- Markers
- Tape
- Solar System Statistics cards
  (See printable cards after page 45. The cards are set up to print double-sided.)

Activity 1: Solar System Model (Distance)

Get kids thinking

Our solar system is BIG! The sizes of the planets vary greatly as do the distances between planets and their distance from the Sun. Start by asking about distances kids have traveled.

- How many miles is it from home to school? How much time does the trip take?
- How long would it take and how many miles would you have to travel from where you live to get to London, England, or to La Paz, Bolivia? What about to Mars?

Let's get started!

Mars is relatively close to Earth, while the Sun and other planets even farther away. Talk about scale and how good a way to show the vast distances among the planets is to make a scale model that is smaller than the actual size of the solar system.

Talk about the planets with the kids.

Step 1: Identify the planets

Ask kids: Can they can name all the planets in the solar system?

- As you **name them** together, have kids **write each planet name** down on its own index card or small piece of paper along with the average distance (in miles) of each planet from the Sun. These are big numbers, so share the distance chart on page 31 to help.
- Instead of writing, kids can cut out and use the Solar System Statistics cards. (See printable cards after page 45. The cards are set up to print double-sided.)
- Once you have cards for each planet, have kids put them in order from nearest the Sun to farthest.

Activity 1: Solar System Model (Distance)

Step 2: Decide on the scale for your model

Toilet paper sheets are going to represent the distances of planets from the Sun in this model. What's fun about making this model is deciding the scale. If you have a lot of space , consider a scale of 10,000,000 (10 million) miles equals 1 square of toilet paper. That will put Neptune about 1,100 sheets or 94 feet away from your "Sun." (See the **Expanded Distance Table** on the fiollowing page if you plan to use this scale.)

- As you think about your scale, ask kids to estimate space available for the model.
- Have them measure a square of toilet paper and predict if their model will fit into the available space.
- Provide kids with a copy of the **Expanded Distance Table**. The table is for this scale: **10,000,000 miles = 1 square of toilet paper** (95 feet of floor or outdoor space needed)

Alternative scale options

If you do not have access to 95 feet of room, you can calculate the numbers for a scale that requires only about 20 feet of space. This is a good math challenge for kids who like to do calculations! 50,000,000 miles = 1 square of toilet paper (19 feet of floor or outdoor space needed)

For younger kids, you can use this simplified chart below:

Planet	Squares	Average distance from Sun
Mercury	2.0	36 million miles
Venus	3.7	67 million miles
Earth	5.1	93 million miles
Mars	7.7	142 million miles
Jupiter	26.4	484 million miles
Saturn	48.4	888 million miles
Uranus	97.3	1.8 billion miles
Neptune	152.5	2.8 billion miles

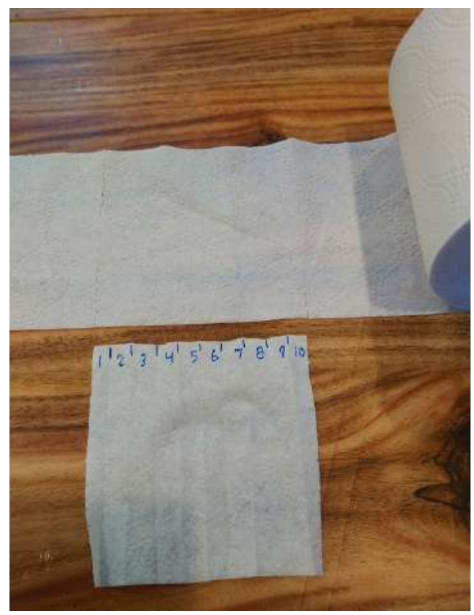
Expanded Distance Table **10,000,000 miles = 1 square of toilet paper** (95 feet of floor or outdoor space needed)

PLANET	True Average Distance to the Sun in Miles	Rounded Average Distance to Sun in Miles	Distance to Sun in Sheets* (10,000,000 miles/sheet) * 4-inch toilet paper squares	Distance to Sun in Inches	Distance to Sun in Feet	Distance Between Each Planet in Sheets
MERCURY	35,983,610	36,000,000	3.6	14.4	1.2	
VENUS	67,232,360	67,000,000	6.7	26.8	2.3	
EARTH	92,957,100	93,000,000	9.3	37.2	3.1	
MARS	141,635,300	142,000,000	14.2	56.8	4.7	
JUPITER	483,632,000	484,000,000	48.4	193.6	16.2	
SATURN	888,188,000	888,200,000	88.8	352.2	29.6	
URANUS	1,783,950,000	1,800,000,000	180	720	60	
NEPTUNE	2,798,842,000	2,800,000,000	280	1,120	93.3	

Activity 1: Solar System Model (Distance)

Step 3: Make your model

- Make an index card for the Sun (or a construction paper Sun) and secure it on the ground (with tape if you are inside, set a rock on top of it if you are outside).
- Attach the toilet paper to the index card with tape.
- Lay the toilet paper down, slowly walk and unroll the toilet paper. (If you are outside and it is even a little windy, get some rocks to hold the toilet paper in place.)
- As you unroll, count the number of squares.
- When you reach Mercury (3.6 sheets on a 10,000,000 mile scale), use a marker to make a dot on the toilet paper and secure the Mercury card next to that square.
- If you want to be precise about where to put the dot, turn a square of toilet paper into a tool that can help. (See photo on the right)
- Continue unrolling the toilet paper and placing the planet cards until you get all the way to Neptune! Far out, right?



For an added challenge

Ask kids if they have a plan for keeping track of their mileage.

For example, Venus is 6.7 sheets from the Sun, but only 3.1 sheets from Mercury. Will they count sheets from the Sun for each planet? See if they can calculate the number of sheets between each planet and add that information to their distance chart. Or, find out if they have another idea to keep their model accurate.

Activity 1: Solar System Model (Distance)

Step 4: Talk about your model

Now that kids have an idea of the relative distance between planets, what do they think?

Ask kids:

- Why is it important to know these distances?
- Who is it important to?
- How do the distances between planets get measured?
- What units are the best units for measuring these distances?

As you discuss, be sure to explain to kids that the distances they used to create their model represent the planets *average distances* from the Sun.

- Planetary **orbits** are **elliptical** and not circular, so the distances change depending on the planet's orbit.
- Also, be sure to point out that orbiting planets are never all in a straight line going out from the Sun as they are represented in this toilet paper model.
- And worth sharing: astronomers measure distances in the solar system in "astronomical units" or AU. 1 AU = 93 million miles, the distance from the Sun to the Earth.
- Talk about what a solar system model that demonstrates the relative average distances between the planets and the Sun and the relative sizes of the planets would look like.

Save your Solar System Statistics cards for future activities.

More model solar system activities

Scale Model of our Solar System (University of Manitoba)
https://umanitoba.ca/observatory/outreach/solarsystem/

The Thousand-Yard Model or, the Earth as a Peppercorn (National Optical Astronomy Observatory)
https://www.noao.edu/education/peppercorn/pcmain.html

Solar System Bead Activity (NASA)
https://www.jpl.nasa.gov/edu/teach/activity/solar-system-bead-activity/

Activity 2: Sizes in the Solar System

Introduction

The sizes of the **planets** relative to each other and the distances between them are very large. This makes a true **scale** model of the solar system really difficult to make. Either the planets are correct in size but too close together, or the distances between them are correct but the planets are too small to see. Kids can get a sense of the relative sizes of the planets when they create models of the objects in our solar system.

Supplies

- Collection of different sized balls: ping pong, golf, tennis, basketball, soccer, a really big exercise ball
- Different-sized marbles
- Different-sized ball bearings
- Other round objects of different sizes, including beads, pebbles, pinheads, etc.
- Buttons, coins, bottle caps, frisbee
- A few grains of sand, poppy seeds, salt

"Sizing up the Solar System" chart (for each child)

- Ruler
- Yellow craft paper (optional)
- Paper
- Drawing compass
- Markers
- Scissors
- Tape

Access to a basketball court makes this activity easier.

Activity 2: Sizes in the Solar System

Get kids thinking

Watch: Watch This Guy Build a Massive Solar System in the Desert
https://youtu.be/Kj4524AAZdE

Let's get started!

Step 1: Choose objects for your model

Spread out all the round objects you have and get kids exploring and talking about the objects. **Ask kids:**

From what you've read and learned about the planets, what objects best represent the planets' size in relationship to each other?

- Which planet is the largest and smallest?
- What object here is the largest? Smallest?
- Most nearly the size of Earth?
- What's the biggest thing in the solar system?
- How big is an asteroid compared to a planet?

After getting close up with the objects, have kids record their ideas about relative size in the Sizing Up the Solar System chart (see page 40).

Using the ideas they've recorded,

- Have kids lay out the objects they chose to represent bodies in the solar system and explain their choices.
- Have them look at their Solar System Statistics cards and put the planets in order from smallest to largest.

Ask kids: How well does what you know about actual planet size match up with the relative sizes of the objects you chose to represent the planets?

Activity 2: Sizes in the Solar System

Step 2: Think about diameter

Now that kids are thinking about actual size and scale size proportions, together as a group make a solar system model using scaled diameters. The table below includes the Sun, planets, and other bodies shown to scale in size proportions. On this scale:

- The Sun will be about 12 feet in diameter — the size of the center circle on a basketball court!
- Mars will be the size of a penny
- The Vesta asteroid is a grain of sand.

Have kids look over the scaled diameters and think about the round objects they examined earlier. **Ask kids:** Which objects are a good fit for this model? How can you tell?

	True Diameter in Miles	Aproximate Scaled Diameter Diameter in Inches
Sun	864,938	144
Mercury	3,032	0.5
Venus	7,521	1.25
Earth	7,926	1.3
Earth's moon	2,159	36
Vesta asteroid	329	.05
Mars	4,222	7
Jupiter	88,846	14.8
Saturn	74,898	12
Uranus	31,763	4.8
Neptune	30,778	4.7
Pluto	1,473	0.23

Activity 2: Sizes in the Solar System

Head to the nearest basketball court to build your model.

- Use yellow craft paper to cover the center court circle to represent the Sun. Have kids write facts about the Sun and questions they still have right on the Sun's surface.
- Kids should select objects they think could represent the other bodies in the solar system model.
- Have them measure the objects to see if they match the scaled diameters. If they can't find an appropriately sized object, have them use a compass to draw one.
- Secure small objects on paper so they can be labeled and seen!
- Kids should write facts and questions they still have for each body.
- Add the objects to the model by placing them in order next to the Sun.

Step 3: Use your model to think about the solar system

When all the pieces of the solar system are in place, **ask kids:**

- What are some of the main differences of the objects in the solar system?
- What is similar about all the planets?

As you discuss, you'll want talk about the differences in size and composition:

- Five planets are solid
- Four planets — Saturn, Jupiter, Uranus and Neptune — are made of gas
- The atmospheres and temperatures of every planet are different
- All planets are spherical, rotate on their axes, and revolve around the Sun in the same direction (counterclockwise)
- In addition to revolving around the Sun, each planet also spins, or rotates, on its own axis.

Activity 2: Sizes in the Solar System

Step 4: Make your model MOVE!

Orbiting the Sun

Time to get your model moving! Have kids get their Solar System Statistics cards and look at the rotational periods and orbital periods for the planets. Start with Earth. **Ask kids:**

- What looks familiar about those numbers?
- How do we refer to those periods of time?
- Have them compare Earth's day and year with the rotational periods and orbital periods of other planets.
- And what's Earth's moon doing?

Demonstrate the differences in orbital periods with Earth and Mars. Mars takes almost twice as long to orbit the Sun as the Earth.

- Have two kids represent Earth and Mars and make their year-long trip around the Sun.
- Mars should move much more slowly than Earth.
- "Mars" and "Earth" can also rotate as they orbit.

Have other kids choose a planet, pick up the object representing it and walk its orbit around your model Sun. When kids start the orbits of other planets, have them adjust their pace for the planet's orbital period.

Step 5: Talk about exploring the our solar system

Now that they understand what's out in the solar system, get kids thinking about exploring it! Discuss what kids know about space exploration, find out what they want to learn, and get ready to launch into more books and activities.

Save your Solar System Statistics cards and models for future reference and activities.

Activity 2: Sizes in the Solar System

More model solar system activities

Solar System in My Neighborhood (Lunar and Planetary Institute)
https://www.lpi.usra.edu/education/explore/solar_system/activities/familyOfPlanets/solarSystem/

Where Are We in the Solar System? (NASA)
https://www.jpl.nasa.gov/edu/teach/activity/jewel-of-the-solar-system-part-2-where-are-we-in-the-solar-system

Scale Model of the Sun and Earth (NASA)
https://sunearthday.nasa.gov/2007/materials/solar_pizza.pdf

If the Moon Were Only One Pixel: A tediously accurate map of the solar system
https://joshworth.com/dev/pixelspace/pixelspace_solarsystem.html

Sizing Up the Solar System

2

Space Object	Why You Chose It
Sun	
Mercury	
Venus	
Earth	
Earth's moon	
Vesta asteroid	
Mars	
Jupiter	
Saturn	
Uranus	
Neptune	
Pluto	

Activity 3: Comet on a Stick

Introduction

Comets are large balls of ice, frozen gas, and dust, sort of like outer space snowballs! They travel in long, **elliptical orbits** around the Sun — it can take hundreds of years to complete one orbit. When a comet gets close to the Sun, the ice turns to gas and together with the dust it streams out to create two long tails. If the comet passes closes to Earth, we can see the tails as bright streaks in the night sky. Comet dust tails can be 6 million miles long and can sometimes stretch almost 100 million miles!

Supplies

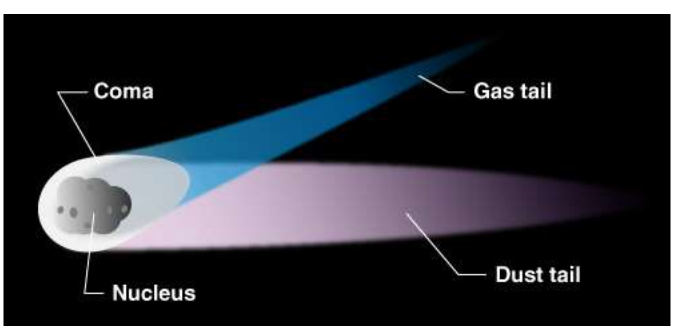
- Chopsticks, popsicle sticks, wooden skewers, or glow sticks (one per child)
- Aluminum foil (12-inch wide)
- Metallic ribbon, mylar strips, or regular ribbon — 3-6 ft per child
- Ruler
- Scissors
- Hairdryer (optional)

Get kids thinking

Watch: Comets and Astriods (SciShow Kids): https://www.youtube.com/watch?v=02wrLS-ue1Q

Comets have four parts: (1) the solid nucleus made of rock, dust, gas, and ice; (2) the coma, a fuzzy cover of ice and dust; (3) a gas tail; and (4) a dust tail.

Ask kids: Have you ever seen a comet in the night sky? What did it look like?



Activity 3: Comet on a Stick

Let's get started!

In this challenge, kids will make a simple model of a comet and then observe what happens when their comet gets close to the Sun.

Making the comets

- Preparation: Cut five pieces of ribbon: two long pieces, two medium pieces, and one short piece for each child. If you want an extra long tail, make the long pieces about three feet in length. For each child, cut three pieces of aluminum foil so they're roughly 6" x 6".
- Show kids how to tie the ribbons around the end of the chopstick, popsicle stick, skewer, or glow stick. To make the ribbon to be as long as possible, tie the knot close to the edge of the ribbon. The ribbons are your comet tails.
- Tell kids to hold the ribbon pieces off to one side and gather the tin foil around the end of the stick with the knot of ribbons. The aluminum foil creates the nucleus and coma.
- Have kids repeat with two more sheets of foil. Gather it around and form it into a ball. If you want a bigger comet, add more aluminum foil!

Now your comet is ready to fly! Tell kids to hold the stick of their comets and run around the room with enough speed so that the ribbon "tails" are flying behind them.

Demonstrating the solar wind

The solar wind is a stream of electrically charged particles that are constantly shooting out of the Sun. Astronauts and spaceships need to steer clear!

The solar wind causes the coma to flow back behind the nucleus, forming the two tails of the comet. Because it is blown by the solar wind, the comet's tail always points directly away from the Sun.

Use a hairdryer to demonstrate the solar wind — the Sun's energy as it meets the comet. Have one child be the Sun and stand in place with the hairdryer turned onto high speed. Have the kids approach the hairdryer, one at a time. **Ask kids:** what happens to your comet as you get closer to the Sun?

Writing About the Solar System

Writing helps kids process and solidify new knowledge and gives them an opportunity to use new vocabulary and concepts. Offer one or more of these prompts or questions to get your Space Rangers writing. Look at your list of solar system words for inspiration.

Inspired by music

In the early 20th century, composer Gustav Holst wrote a seven-part suite for an orchestra called *The Planets*. Each part was inspired by and named after one of the seven planets in our solar system and their astrological character:

- Mars, the Bringer of War
- Venus, the Bringer of Peace
- Mercury, the Winged Messenger
- Jupiter, the Bringer of Jollity
- Saturn, the Bringer of Old Age
- Uranus, the Magician
- Neptune, The Mystic

Listen!

Holst's *The Planets*: https://www.youtube.com/watch?v=Isic2Z2e2xs&t=2399s

'The Planets' at 100: A Listener's Guide to Holst's Solar System (NPR): https://www.npr.org/sections/deceptivecadence/2018/09/28/652700640/the-planets-at-100-a-listener-s-guide-to-holst-s-solar-system

Gustav Holst's 'The Planets': a guide (Classic FM): https://www.classicfm.com/composers/holst/pictures/holsts-planets-guide/

Get kids thinking

Talk about a planet and what we know about it. Ask the kids to listen to a portion of the piece about that planet and imagine that they ARE the planet. Does the music suit them? How do they feel when they hear the music? What is the planet thinking or what is happening on or to the planet as the music is playing?

Writing About the Solar System

Writing prompts

Write about a planet — from the planet's point of view! Give a first-person account of a planet, providing details about your place in the solar system. What do you want everyone to know about you?

Imagine that you are a reporter assigned to get the inside story about how Pluto feels about its status change to dwarf planet.

Play with words

Write a list poem about the solar system. Create a thoughtful list that focuses on the relationship between the Sun and all the other objects in the solar system. Create additional Planetary Poetry using other poetic forms:
https://www.jpl.nasa.gov/edu/teach/activity/planetary-poetry/

Travel the solar system

You've just opened a new travel business to take passengers on tours of the solar system. Create a detailed itinerary (what's going to happen on the trip) that gives passengers information about the planets they will be visiting, how long it will take them to get there, and what they should pack!

Planet puppet show

Share your knowledge of the solar system with others! Write an original script or adapt one of the books you read about the solar system and use the planet models you created to put on an out-of-this world performance filled with fun facts about the planets and their place in our solar system.

Kid-friendly Websites and Apps

Websites

A Tour of the Solar System (Sea and Sky)
http://www.seasky.org/solar-system/solar-system.html

Planet Compare
https://callumprentice.github.io/apps/planet_compare/

Video: Solar System Playlist (National Geographic Kids)
https://kids.nationalgeographic.com/explore/youtube-playlist-pages/youtube-playlist-solar-system/

Space Place (NASA)
https://spaceplace.nasa.gov/

Interactive: The Story of the Solar System (American Museum of Natural History)
https://www.amnh.org/explore/videos/space/impact%21-tracking-near-earth-asteroids/interactive-the-story-of-the-solar-system

Tour the Solar System (PBS Learning Media)
https://www.pbslearningmedia.org/resource/buac18-68-sci-ess-toursolarsystem/tour-the-solar-system/

Solar System (BrainPOP)
https://www.brainpop.com/science/space/solarsystem/

Educational apps

NASA (Apple)
https://www.commonsensemedia.org/app-reviews/nasa

Solar System Explorer (Android)
https://www.commonsense.org/education/app/solar-system-explorer

Britannica Kids: Solar System (Apple) $
https://www.commonsensemedia.org/app-reviews/britannica-kids-solar-system

Solar System (Apple) $
https://www.commonsensemedia.org/app-reviews/solar-system-for-ipad

Sun

The sun is a massive ball of gas and the largest body in the solar system.

Diameter	863,400 miles (1,390,000 km)
Surface Temperature	10,800° F (6,000° C)
Interior Temperature	27,000,000° F (15,000,000° C)
Rotational Period	25–36 days
Estimated Age	4.5 billion years
Primary Chemical Component	Hydrogen

Mercury

Mercury is the closest planet to the sun and the smallest in the solar system.

Diameter	3,031 miles (4,880 km)
Natural Satellites	0
Distance from the Sun	35,974,272 miles (57,910,000 km)
Rotational Period	58.65 days
Orbital Period	87.97 days
Surface Temperature	354° F (179° C)
Main Atmospheric Component	Helium

Venus

The second planet from the sun, cloud-covered Venus rotates from east to west.

Diameter	7,518 miles (12,103 km)
Natural Satellites	0
Distance from the Sun	67,214,920 miles (108,200,000 km)
Rotational Period	243.0 days
Orbital Period	224.7 days
Surface Temperature	899° F (482° C)
Main Atmospheric Component	Carbon Dioxide

Earth

The only planet with liquid water on its surface, it is the only planet to support life.

Diameter	7,924 miles (12,756 km)
Natural Satellites	1
Distance from the Sun	92,933,000 miles (149,600,000 km)
Rotational Period	23 hours, 56 mins
Orbital Period	365.2 days
Surface Temperature	354° F (179° C)
Main Atmospheric Component	Nitrogen

Mars

The fourth planet from the sun is a barren, rocky, rusty red world.

Diameter	4,220 miles (6,794 km)
Natural Satellites	2
Distance from the Sun	141,050,000 miles (227,940,000 km)
Rotational Period	24.62 hours
Orbital Period	687 days
Surface Temperature	-81° F (-63° C)
Main Atmospheric Component	Carbon Dioxide

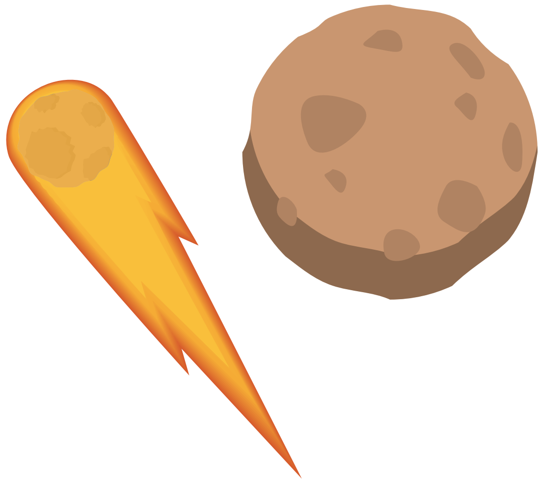
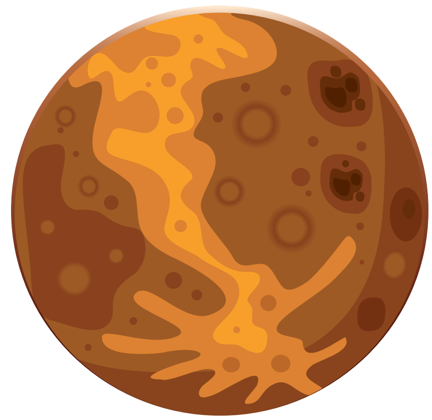
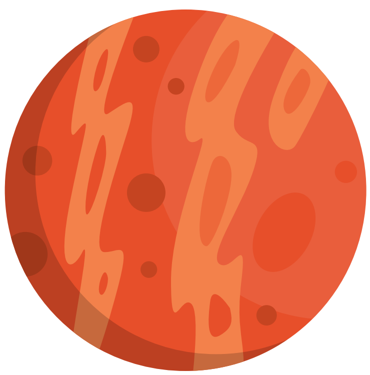
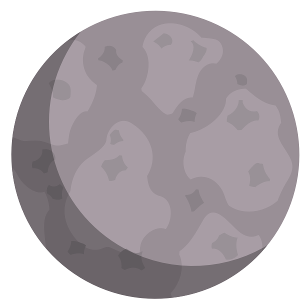
Asteroids and Comets

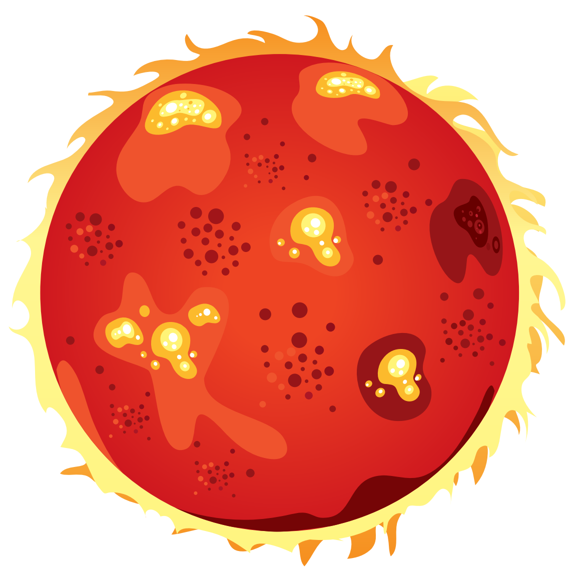
Asteroids are big space rocks left over from when the solar system formed about 4.6 billion years ago. Most asteroids orbit the sun within the main asteroid belt between Mars and Jupiter.

Number of known asteroids: 794,770

Comets are the oldest, most primitive bodies in the Solar System. They are huge snowballs of frozen gases, rock, and dust that orbit the sun. When close to the sun, a comet heats up, and its dust and gases form a tail that stretches for millions of miles.

Number of known comets: 3,570



Jupiter

Almost twice the size of all of the other planets combined and has a giant red spot.

Diameter	88,823 miles (142,984 km)
Natural Satellites	64 known
Distance from the Sun	482,546,000 miles (778,330,000 km)
Rotational Period	9.84 hours
Orbital Period	4333 days
Cloud Temperature	-185° F (-121° C)
Main Atmospheric Component	Hydrogen

Saturn

Saturn, a gas giant with three main bands of rings, is called the jewel of the solar system.

Diameter	74,565 miles (120,536 km)
Natural Satellites	62
Distance from the Sun	884,740,000 miles (1,429,400,000 km)
Rotational Period	10.25 days
Orbital Period	29.46 years
Cloud Temperature	-193° F (-125° C)
Main Atmospheric Component	Hydrogen

Uranus

The only planet that rotates on its side, Uranus is a featureless blue-green sphere.

Diameter	31,755 miles (51,118 km)
Natural Satellites	27
Distance from the Sun	1,783,487,000miles (2,870,990,000 km)
Rotational Period	17.3 hours
Orbital Period	84 years
Cloud Temperature	-315° F (-193° C)
Main Atmospheric Component	Hydrogen

Neptune

A giant blue sphere with unusual cloud features and a thin, dark system of rings.

Diameter	30,744 miles (49,492 km)
Natural Satellites	13
Distance from the Sun	2,798,116,000miles (4,504,300,000 km)
Rotational Period	15.8 hours
Orbital Period	165 years
Cloud Temperature	-315° F (-193° C)
Main Atmospheric Component	Hydrogen

Pluto

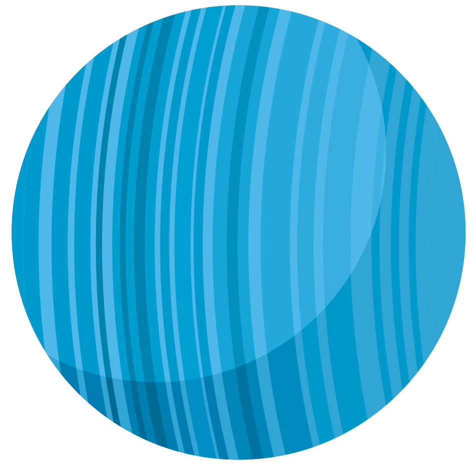
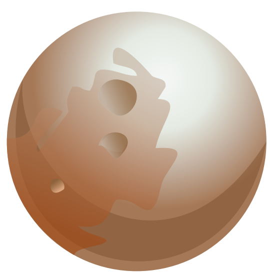
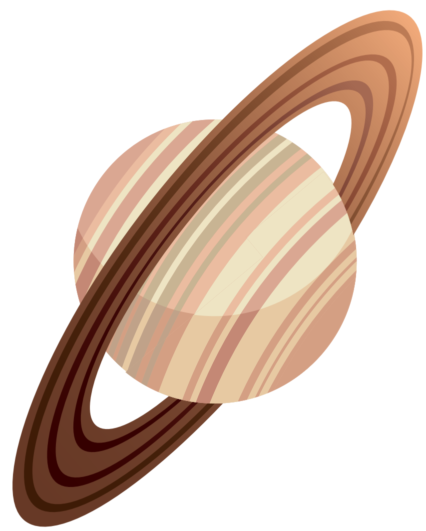
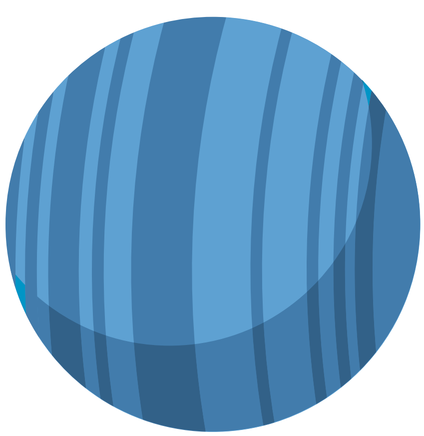
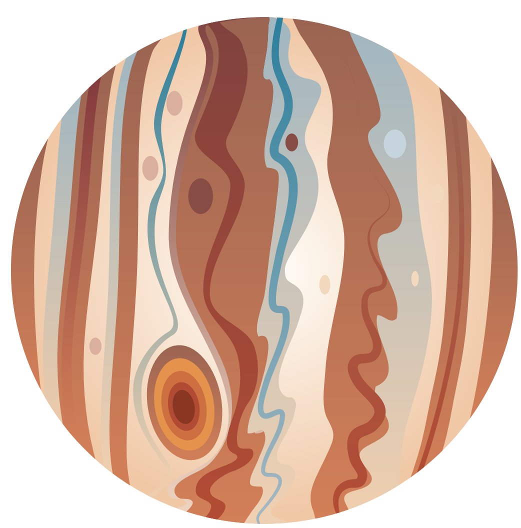
Pluto is officially classified as a dwarf planet and has an oval and tilted orbit.

Diameter	1,473 miles (2,370 km)
Natural Satellites	5
Distance from the Sun	3,673,537,000miles (5,913,520,000 km)
Rotational Period	6.3 days
Orbital Period	248 years
Surface Temperature	-382° F (-230° C)
Main Atmospheric Component	Methane

Moon

Our moon is the 5th largest of the 190+ moons orbiting planets in the solar system.

Diameter	2,160 miles (3,476 km)
Natural Satellites	0
Distance from the Earth	238,800 miles (384,400 km)
Rotational Period	27.32 days
Orbital Period	27.32 days
Surface Temperature	0° F (-17° C)
Main Atmospheric Component	Hydrogen

Day 3
The Moon

Day 3
The Moon

Introduction

The **Moon** is about 4.5 billion years old. Scientists think that a large **asteroid** hit the Earth, and the hot, melted rock thrown into space formed the Moon.

The Moon is Earth's nearest neighbor and our only natural **satellite**. It takes 27 days for the Moon to **revolve** around the Earth — in fact, the Moon's **orbit** around Earth inspired our calendar month. Humans have always been interested in the Moon because it affects our **tides,** we can observe it change throughout the month (the **phases of the Moon**), and we can even see the Moon's many **craters** without a telescope.

On July 20, 1969, two astronauts walked on the **lunar** surface for the first time, part of the three-man American crew of the historic **Apollo 11** mission. We're celebrating the 50th anniversary of Apollo 11 this year!

Questions to guide explorations and experiments

- What is the surface of the Moon like? Where do all the craters come from?
- What are the phases of the Moon? How do they relate to the Moon's orbit?
- How did humans get to the Moon and what was it like when the first astronauts walked on the surface of the Moon?
- How high can I jump on the Moon?
- How do scientists study Moon rocks and other things we've brought back from space?

Books and activities

- **Books:** fiction, nonfiction, and poetry all about our Moon and the Apollo missions
- **Activities:** explore the surface of the Moon, the phases of the Moon, and the historic 1969 Apollo 11 mission.

Children's Books

Fiction

- *A Big Mooncake for Little Star* by Grace Lin (Ages 4-8)
- *City Moon* by Rachael Cole (Ages 4-8)
- *I Love You, Michael Collins* by Lauren Baratz-Logsted (Ages 9-12)
- *Imani's Moon* by JaNay Brown-Wood (Ages 6-9)
- *The Man in the Moon* by William Joyce (Ages 6-9)
- *A Moon of My Own* by Jennifer Rustigi (Ages 6-9)
- *The Moon Over Star* by Dianna Hutts Aston (Ages 6-9)
- *Music for Mister Moon* by Philip C. Stead (Ages 4-8)
- *Owl Moon* by Jane Yolen (Ages 4-8)
- *Starry River of the Sky* by Grace Lin (Ages 9-12)
- *Thanking the Moon* by Grace Lin (Ages 4-8)
- *There Was an Old Martian Who Swallowed the Moon* by Jennifer Ward (Ages 4-8)
- *Where the Mountain Meets the Moon* by Grace Lin (Ages 9-12)

Poetry

- *Comets, Stars, the Moon, and Mars: Space Poems and Paintings* by Douglas Florian (Ages 6-9)
- *Eight Days Gone* by Linda McReynolds (Ages 4-8)
- *Faces of the Moon* by Bob Crelin (Ages 6-9)
- *A Full Moon Is Rising* by Marilyn Singer (Ages 6-9)
- *Out of This World: Poems and Facts About Space* by Amy Sklansky (Ages 6-9)
- *Thirteen Moons on Turtle's Back: A Native American Year of Moons* by Joseph Bruchac (Ages 4-8)
- *When the Moon Is Full: A Lunar Year* by Mary Azarian (Ages 6-9)

Biography

- *A Computer Called Katherine: How Katherine Johnson Helped Put America on the Moon* by Suzanne Slade (Ages 6-9)
- *Hidden Figures* by Margot Lee Shetterley (Ages 6-9)
- *Margaret and the Moon: How Margaret Hamilton Saved the First Lunar Landing* by Dean Robbins (Ages 4-8)
- *Who Was Neil Armstrong?* by Roberta Edwards (Ages 9-12)

Children's Books

Nonfiction

- *Apollo 13 (Totally True Adventures): How Three Brave Astronauts Survived A Space Disaster* by Kathleen Weidner Zoehfeld (Ages 6-9)
- *Countdown: 2979 Days to the Moon* by Suzanne Slade (Ages 9-12)
- *If You Decide to Go to the Moon* by Faith McNulty (Ages 4-8)
- *If You Had Your Birthday on the Moon* by Joyce Lapin (Ages 6-9)
- *Footprints on the Moon* by Alexandra Siy (Ages 6-9)
- *Go for the Moon: A Rocket, a Boy, and the First Moon Landing* by Chris Gall (Ages 6-9)
- *If You Had Your Birthday Party on the Moon* by Joyce Lapin (Ages 6-9)
- *Lost in Outer Space: The Incredible Journey of Apollo 13* by Tod Olson (Ages 9-12)
- *The Moon Book* by Gail Gibbons (Ages 6-9)
- *Moon! Earth's Best Friend (Our Universe)* by Stacy McAnulty (Ages 4-8)
- *The Moon Seems to Change* by Franklyn Branley (Ages 4-8)
- *Moonshot* by Brian Floca (Ages 6-9)
- *One Giant Leap* by Robert Burleigh (Ages 6-9)
- *What the Moon Is Like* by Franklyn Branley (Ages 4-8)
- *Team Moon: How 400,000 People Landed Apollo 11 on the Moon* by Catherine Thimmesh (Ages 9-12)
- *You Can't Ride a Bicycle on the Moon* by Harriet Ziefert (Ages 6-9)

Space Words

Apollo 11
The historic mission where humans first walked on the Moon.

Asteroid
A rocky space object that can be a few feet wide to several hundred miles wide. Most asteroids in our solar system orbit in a belt between Mars and Jupiter.

Astronaut
A person trained to participate in space flights.

Atmosphere
The layer of gases surrounding Mars, Earth, and other planets, held in place by gravity.

Comet
A frozen mass of gas and dust that orbits the Sun and may form a long, bright tail when it is flying close to a sun.

Command Module (Columbia)
The Apollo 11 spacecraft that orbited the Moon while the Lunar Module was on the lunar surface. "Columbia" was piloted by astronaut Michael Collins.

Crater
Large round holes in the ground. A bowl-shaped cavity caused by an asteroid impact.

Crescent Moon
The Moon as it appears early in its first quarter or late in its last quarter, when only a small arc-shaped section is lit up by the Sun.

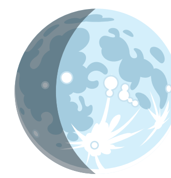
Erosion
The wearing away of a planet's surface by wind or water.

Exosphere
The outermost part of the atmosphere of a planet.

Far Side of the Moon
The side of the Moon that always faces *away* from Earth.

Full Moon
When Earth is located between the Sun and the Moon, the Moon appears fully lit up and appears like a bright, full circle.

Gibbous Moon
The appearance of the Moon between a Half Moon and a Full Moon.



Gravity
A force that pulls matter together; a force that "pulls" people and objects towards the ground.

Half Moon
The phase when one-half of the Moon appears lit up.

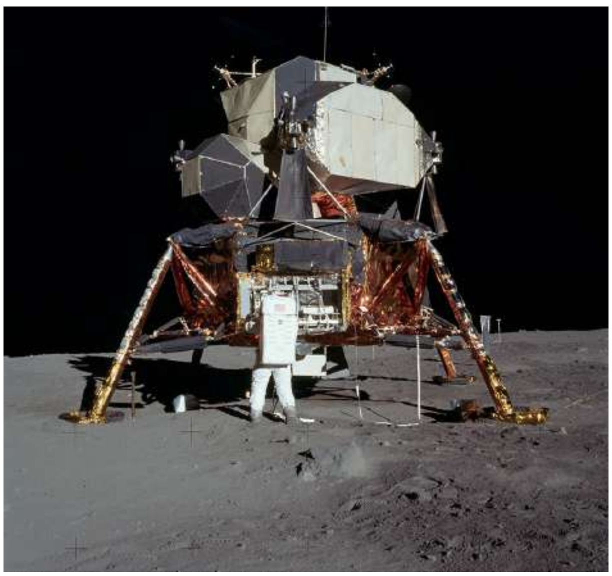
Lunar
Having to do with the Moon, for example, the lunar landscape.

Lunar cycle
The Moon's continuous orbit around the Earth. It takes 27 days, 7 hours, and 43 minutes for our Moon to complete one full orbit around Earth.

Lunar eclipse
When the Moon's reflected light is hidden by the Earth's shadow when the Earth passes between the Moon and the sun.

Space Words

Lunar Module (Eagle)
The Apollo 11 "Eagle" was the first manned spacecraft to land on the Moon. It carried two astronauts, Neil A. Armstrong and Edwin E. "Buzz" Aldrin, Jr., the first men to walk on the Moon.



Maria (Seas)
The dark areas of the Moon that can be seen from Earth.

Meteor (shooting star)
The flash of light in the night sky when a small piece of space dirt burns up as it passes through Earth's atmosphere.

Moon
A natural satellite that orbits a larger object. Earth has one Moon, the one we see in the night sky.

Near Side of the Moon
The side of the Moon that always faces towards Earth.

New Moon
When the Moon is between Earth and the Sun, the Moon receives no direct sunlight and appears like a dark circle.

Orbit
The curved path followed by an object in space as it goes around another object; to travel around another object in a single path. The Moon orbits the Earth.

Phases of the Moon
The different ways the Moon looks from Earth over about a month.

Revolve
To move in an orbit or circle around a fixed point. The Earth revolves around the sun.

Rotate
To turn around a center point—or axis, like a wheel turns on a bicycle. The Earth rotates from day to night.

Satellite
An object that orbits another object. A moon is a natural satellite.

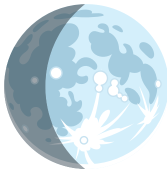
Saturn rocket
The vehicle that launched the Apollo 11 spacecraft and astronauts to the Moon for the first historic Moon walk.

Sea of Tranquility
The lunar landing site for the Apollo 11 mission, the first time man walked on the Moon.

Tides
The rising and falling of the surface of the ocean that occurs twice a day, caused by the pull of the Moon and sun.

Waning Moon
Waning means to decrease or diminish. The Waning Moon phase starts after a Full Moon, and is always illuminated on the left.

Waxing Moon
Waxing means to increase. The Waxing Moon phase starts after a New Moon, and is always illuminated on the right.



Activity 1: Lunar Craters

Introduction

A **crater** is a bowl-shaped cavity formed when an **asteroid** from space hits the surface of a moon or planet.

Both the Earth and the **Moon** have been hit by asteroids, **meteors**, and **comets** many times in their 4.5 billion year history. Some of the craters on the Moon are so big that you can see them without a telescope!

An asteroid is more likely to fall toward Earth than the Moon because of our planet's stronger **gravity**. But we can see many thousands of craters on the **lunar** surface and we only know of a few hundred on Earth. Let's learn why!

Supplies

- Photograph of the Moon with craters (provided)
- A large pan or shallow box
- Flour or sand (enough to make a 2-inch deep layer)
- 1 cup powdered cocoa
- Small sieve or flour sifter
- Large trash bag or piece of cloth to place under the crater box
- Different-sized objects to be used as “impactors” such as large and small marbles, golf balls, rocks, other balls of different sizes
- Ruler
- Paper and pencil
- Chair or step stool to stand on
- Cell phone with slow-motion video recording ability (optional)

Activity 1: Lunar Craters

Get kids thinking

The surface of the Moon is full of craters caused by asteroids dropping from space. Once a crater is formed on the Moon, it never disappears or changes because there is no weather or life on the planet. Once something hits the Moon, that event becomes frozen in time! Only a meteor strike could destroy the footprints, and that's not likely!

When an asteroid hits the Earth, the crater it leaves eventually disappears from the surface. That's because the Earth experiences weather — wind, rain, and snow — that over time can "erase" the crater. Plants, animals, and people change the surface of the Earth, too. No wonder there are so many craters on the Moon compared to Earth!

Show the images of the lunar craters (see pages 54-55). **Ask kids:** Describe what you see. What shape are the craters? Can you find some craters sitting on top of each other? Which formed first and which formed later?

Let's get started!

In this activity, kids will experiment with creating their own lunar craters. They'll experience what happens when an object hits another, softer surface and think about how the craters on the Moon were created.

Fill the baking pan with flour, and set it on the ground or floor, with the plastic or cloth underneath (to make clean up easier).

Use the sieve or sifter to put a thin layer of cocoa on top of the flour. This will make the craters easier to see.

Have each child choose an impactor and drop the object straight down into the pan.

Have the kids observe the impact crater. **Ask kids:**

- What color is the surface immediately around the crater?
- How does that compare to the surface of the rest of the pan?
- How far did the flour and cocoa powder spread? Have the kids use the ruler to measure these distances.

Activity 1: Lunar Craters

Next, have the kids try dropping the same ball from a different height (stand on a chair). **Ask kids:**

- What does the resulting crater look like?
- How did the height affect the size and depth of the crater?

Then try dropping balls of different sizes (and weights) from the same height. **Ask kids:**

- What do the resulting craters look like?
- How did the size and weight affect the size and depth of the craters?

Finally, try throwing a ball sideways so it hits the pan at an angle, instead of coming straight down. **Ask kids:**

- How is the resulting impact pattern different from when you dropped the balls straight down?

If needed, smooth out the surface of the pan, and sift a fresh layer of cocoa powder on top.

Do you have a smartphone with a slow-motion camera setting? Try filming your meteorite impacts in slow motion! What do you see when you watch the videos?

Extensions

Scale this project up! Do you have access to a sandbox, a shovel, and some dirt? Create a large pile of loose material: dirt covered with a layer of sand (similar to the flour covered with cocoa powder). Help kids drop a larger ball (a basketball works well) from a higher location, such as standing on a ladder.

More Moon crater activities

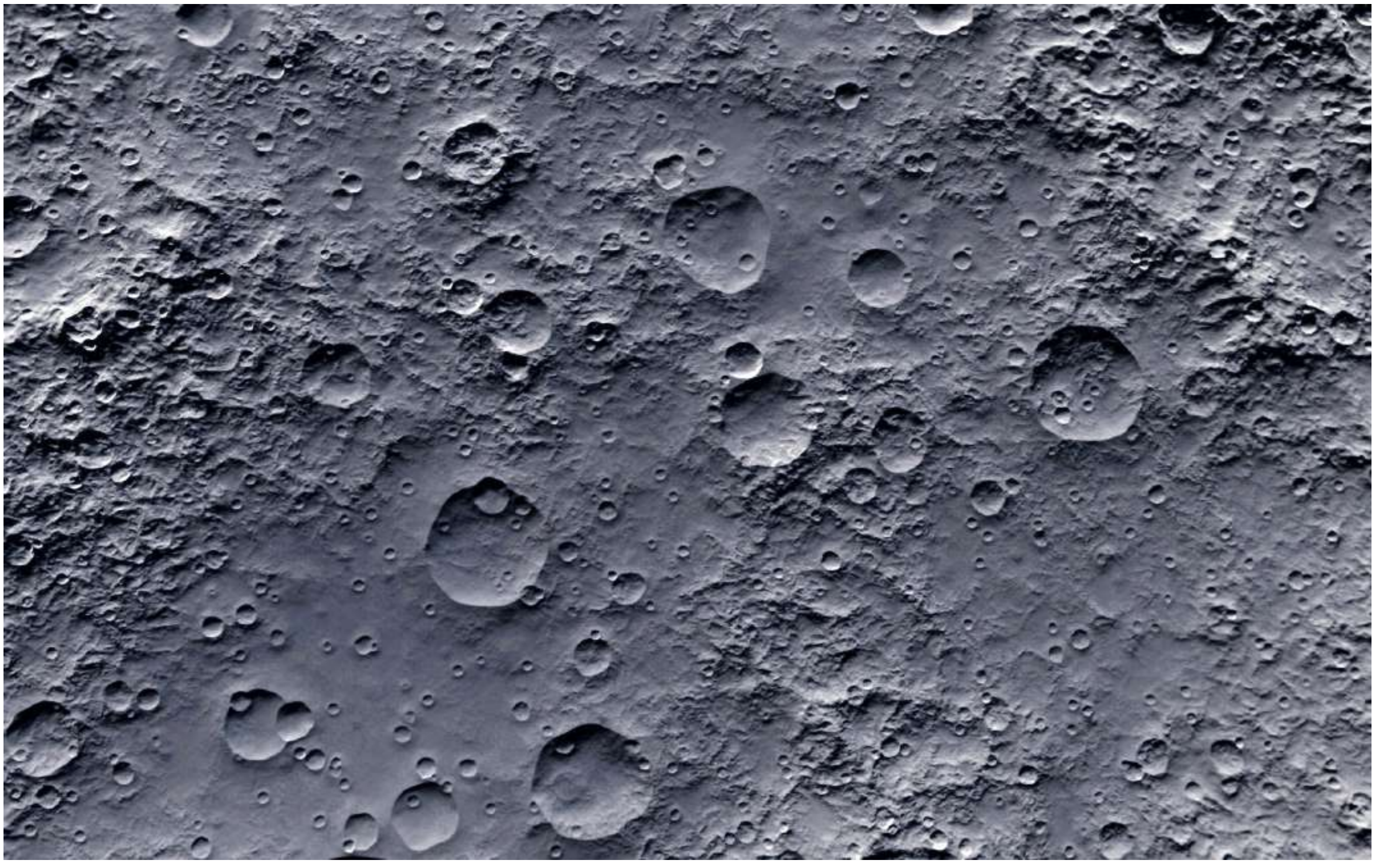
Video: The Moon and Its Craters (PBS Kids, Ready Jet Go!)
https://www.pbslearningmedia.org/resource/ready-get-go-the-moon-and-craters/the-moon-and-its-craters-ready-jet-go/#.XMdBqKR7mUk

How Did the Moon Get Its Craters? (Gift of Curiosity)
https://www.giftofcuriosity.com/how-did-the-moon-get-its-craters-an-art-and-science-activity-for-kids/

Activity 1: Lunar Craters

The lunar surface (Photo © NASA)

Activity 1: Lunar Craters



Close up view of the lunar surface (Photo © NASA)

Activity 2: Phases of the Moon

Introduction

When we look at the Moon over the course of many days, it seems to change its shape — from a full circle to a half-circle to a crescent shape and then gradually back to a full circle again.

The Moon isn't really changing shape — it just appears that way from Earth. Here's why: It takes about four weeks for the Moon to orbit once around the Earth. During this time, the Moon's position in relationship to the Earth and the Sun is constantly changing. As the Moon orbits around the Earth, the part of the Moon that faces the Sun will be lit up. We call the different shapes that are lit up during orbit the "phases of the Moon."

What we sometimes call "moonlight" is really sunlight reflecting off the Moon's surface. The Moon itself puts out no light at all!

Get kids thinking

Invite the kids to describe what the Moon looks like to them and how it changes.

It takes 27 days for the Moon to revolve around the Earth. Talk about how the Moon’s phases are an example in nature of a recurring and predictable cycle.

Ask kids: What is the lunar calendar? The lunar calendar is based on the monthly phases of the Moon. Lunar calendars are still used by many cultures for religious festivals and holidays. Examples include Ramadan, Easter, and Chinese New Year.

Show kids the composite photograph of the 8 phases of the Moon (see the next page). Talk about the position of the Earth in relationship to the Moon and why we always see the same side of the Moon (and never the far side).

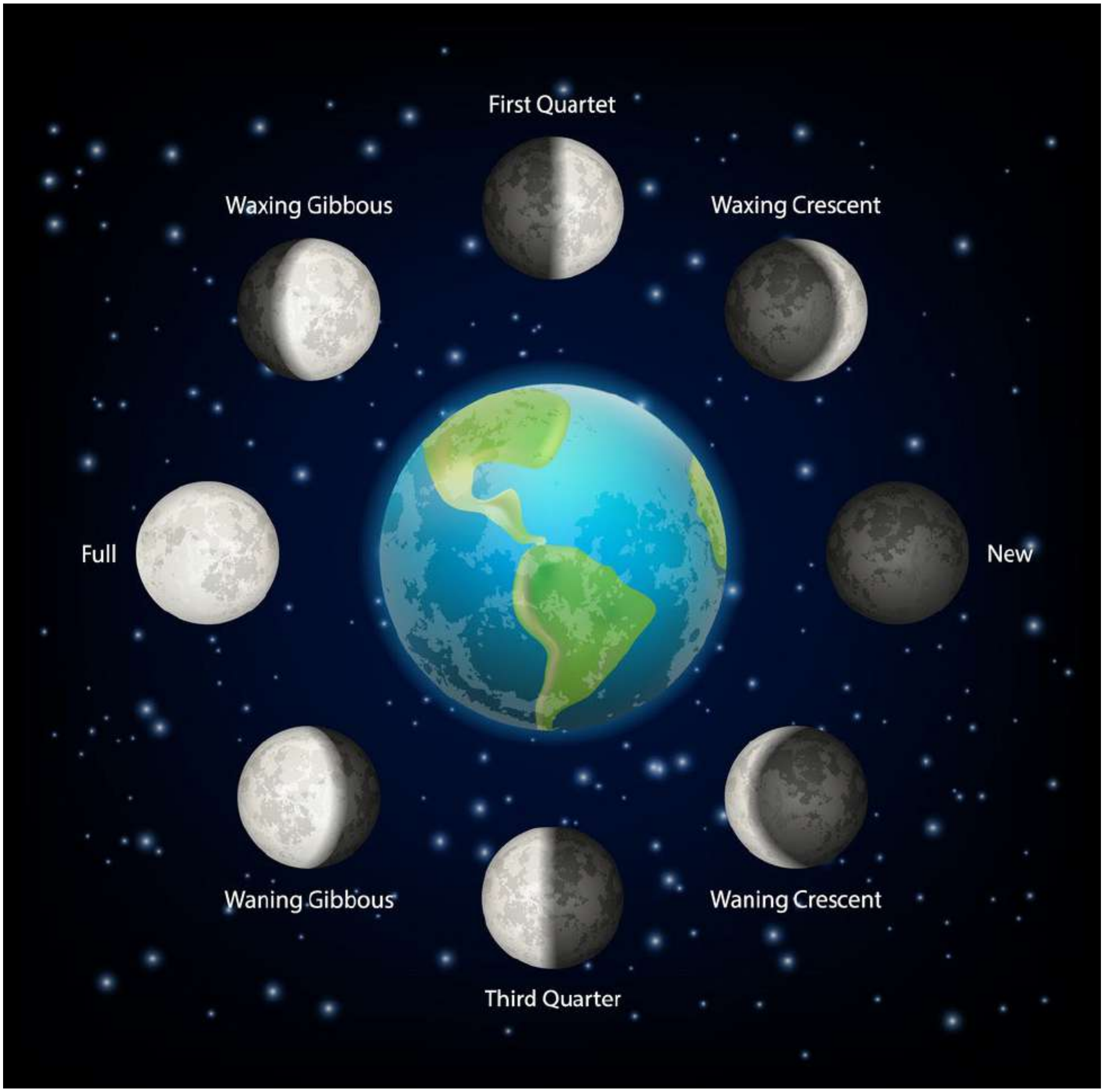
Watch: An animation of the phases of the Moon from NASA's Jet Propulsion Lab: https://www.jpl.nasa.gov/edu/teach/activity/moon-phases/

Ask questions about Moon phases. What makes the Moon shine? How light or dark is it on a full Moon night versus a new Moon/no Moon night? Do you know any stories about the Moon?

Kids can try one or both of these activities to learn about the phases of the Moon.

3

Phases of the Moon



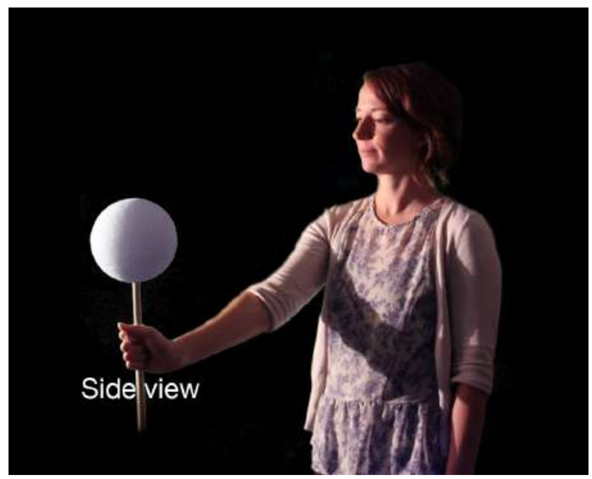
Activity 2: Phases of the Moon Whole Group Activity

Supplies

- Lamp (at least 100 watts) with the lampshade removed
- Ball (a basketball works well) or white Styrofoam® ball on a stick or pencil

This activity needs a darkened room.

Let's get started!



Try this whole-group demonstration to see the phases of the Moon in action! Before trying this with the kids, watch this video: https://www.youtube.com/watch?v=wz01pTvuMa0

Place the lamp in the center of the room. The lamp is the Sun. Have one of the kids hold the ball in her hand. The ball is the "Moon" and her head is the Earth. Darken the room except for the lamp.

Have the child with the ball (the "Moon") stand several feet away from the lamp. Ask her to hold the ball straight out in front of her and face the lamp. The ball will appear dark because the lighted side of the ball is facing away from her. This position represents the **New Moon**.

The other kids will need to stand right behind her and move with her to see the phases.

Holding the Moon straight in front of her, tell the child to turn her body a little bit to the left. Everyone will see a small crescent of light on the right side of the ball. This is called the **New (Waxing) Crescent**.

Now have the child turn to the left a little more until the ball is half lit up. This is called the **First Quarter Moon**, since the Moon has traveled one-quarter of the way around the Earth.

Activity 2: Phases of the Moon Whole Group Activity

Have the child continue turning around the circle until she is halfway around with her back to the lamp. At this point, the whole ball is lit — that's a **Full Moon**. If the child's head is in the way, she's created a lunar eclipse — just have her raise the ball up a bit to see the Full Moon.

Tell the child to continue slowly around the circle until she returns to where she started, while you name the other Moon phases as they appear.

You can then give other kids a chance to be the Moon and rotate through all the phases.

Activity 2: Phases of the Moon
Oreo Cookie Moon Phases

Supplies

- Access to a sink with soap and water or baby wipes for cleaning hands prior to activity
- Bag of Oreo cookies (8 per child, maybe a few extras for breakage or "disappearance"!)
- Popsicle stick for each child for scraping the frosting
- Plates or napkins
- Phases of the Moon template (See pages 62-63)

Let's get started!

Print out copies of the Moon phases template — one sheet for each child. You can choose either of the two templates.

Have children wash their hands or clean their hands with baby wipes before distributing the cookies.

Give each child 8 cookies on a plate or napkin and a clean popsicle stick.

Have each child slowly twist the Oreos to keep most of the frosting on one side when they separate the halves (younger children may need help with this).

Tell the kids use the popsicle stick to scoop away the frosting to illustrate the Moon phases, using the template as their guide.

Have the kids place the cookies in order of how they appear in the sky throughout the month, using the template as their guide.

After everyone has finished their Moon phase display, it's snack time!

Extension

Suggest to kids that together with their parents they look up at the sky tonight — what phase is the Moon in? Kids can share what they observed the next day.

Activity 2: Phases of the Moon

More activities

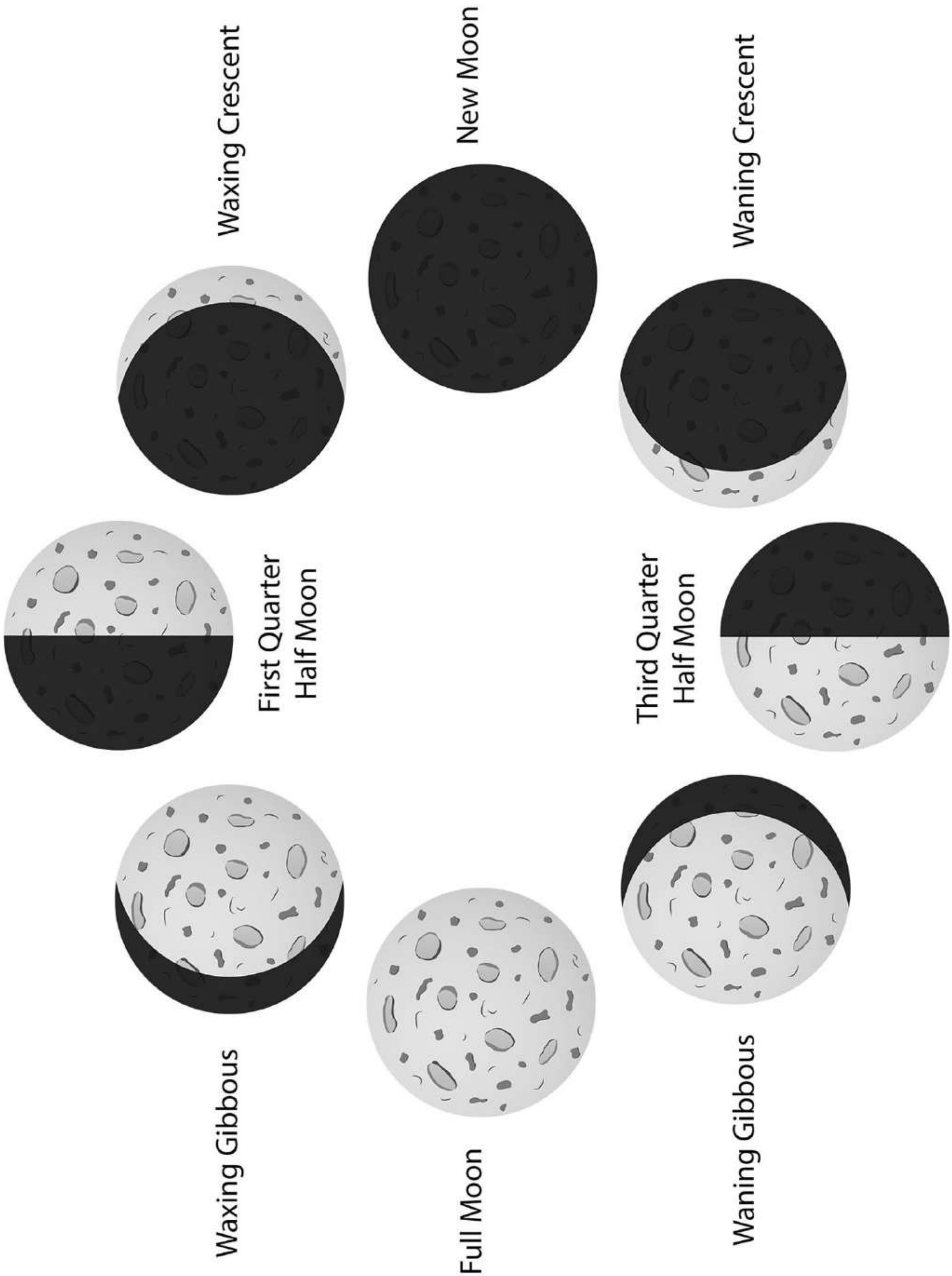
Moon Watch Flip Book (Start With a Book)
https://www.startwithabook.org/sites/default/files/moon-watch-flip-book.pdf
This project takes a full month to complete — great for at home, or summer programs that last more than 4 weeks.

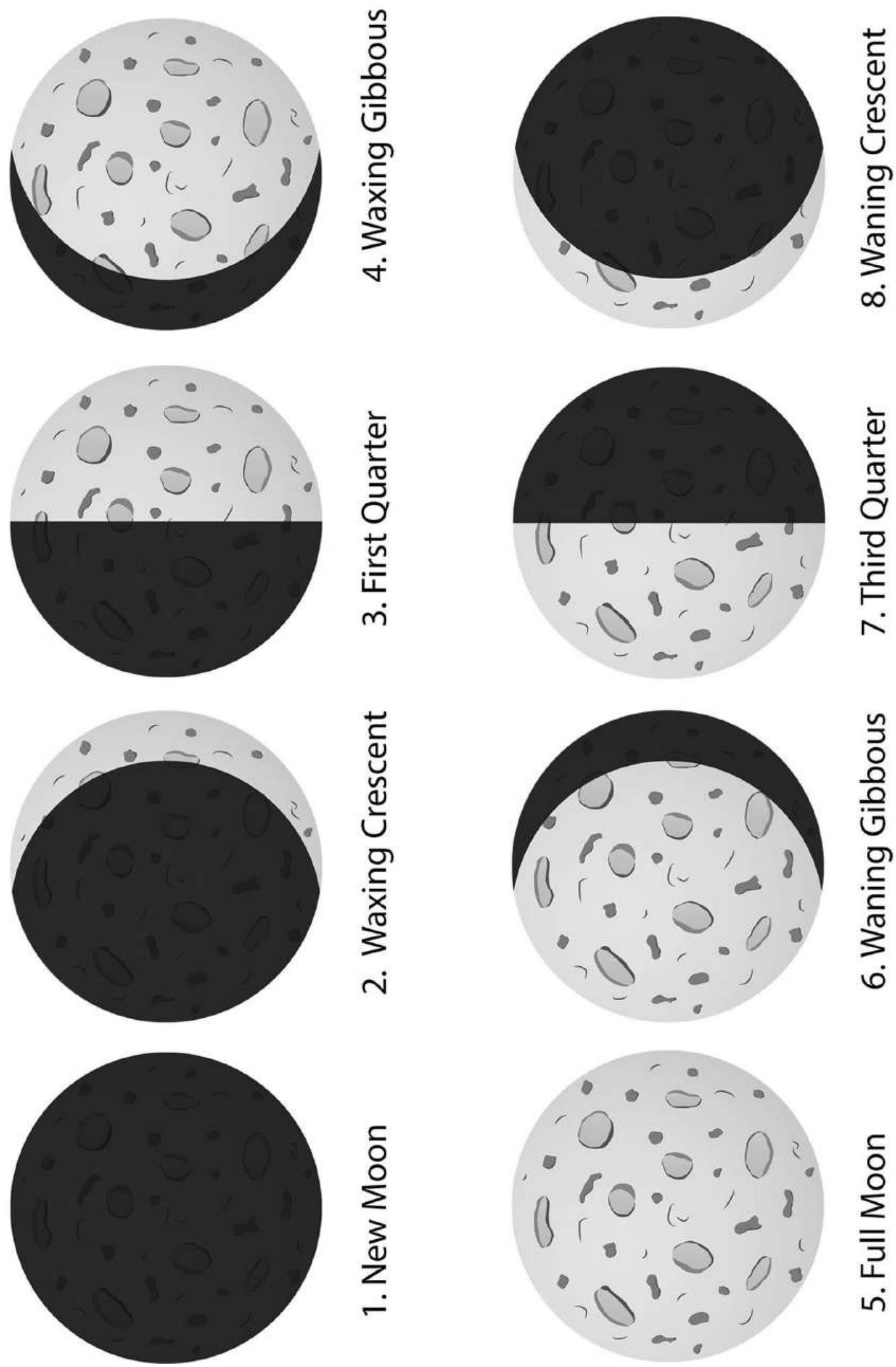
Moon Journal (National Wildlife Federation, Ranger Rick)
https://rangerrick.org/crafts_activities/keep-a-moon-journal/
This project takes a full month to complete — great for at home, or summer programs that last more than 4 weeks.

Moon Phase Transporter (Scholastic)
https://www.scholastic.com/teachers/blog-posts/angela-bunyi/ready-to-edit-teaching-the-moon-phases-seems-to-be-one-of-those-skills-that-is-taught-across-the-grade-leve/

Moon Phases Slider (Teach Beside Me)
https://teachbesideme.com/moon-phases-activity/

Photo © Carla Brown, National Wildlife Federation


New Moon
Waxing Crescent
First Quarter
Half Moon
Waxing Gibbous
Full Moon
Waning Gibbous
Third Quarter
Half Moon
Waning Crescent



1. New Moon
2. Waxing Crescent
3. First Quarter
4. Waxing Gibbous
5. Full Moon
6. Waning Gibbous
7. Third Quarter
8. Waning Crescent

Activity 3: Apollo 11
Landing Humans on the Moon

Introduction

On July 20, 1969, millions of people gathered around their televisions to watch two American **astronauts** do something no one had ever done before. Wearing bulky space suits and back-packs of oxygen to breathe, **Apollo 11** astronauts Neil Armstrong and Edwin "Buzz" Aldrin became the first human beings to walk on the Moon.

After they stepped onto the **lunar** surface, Armstrong said these famous words: "That's one small step for a man, one giant leap for mankind."

Supplies

- Copy of the book *Moonshot: The Flight of Apollo 11* by Brian Floca
- Photograph of the first footprint on the Moon (see large version on page 67)

Get kids thinking

Show this photograph to the kids and ask if they know what it is. **It's a very special footprint.** *This is a footprint of man's very first step on the Moon.*

Photo © NASA

Together, read the picture book ***Moonshot: The Flight of Apollo 11*** by Brian Floca. The book is readily available at public libraries.

Alternative book options:

- *Countdown: 2979 Days to the Moon* by Suzanne Slade
- *One Giant Leap* by Robert Burleigh

The words in *Moonshot* are very simple and expressive; they combine with detailed illustrations to tell the incredible story of how we landed men on the Moon for the first time. It will give the kids a sense of what it felt like from the point of view of the astronauts as well as all the new technology that made it possible.

Activity 3: Apollo 11 Landing Humans on the Moon

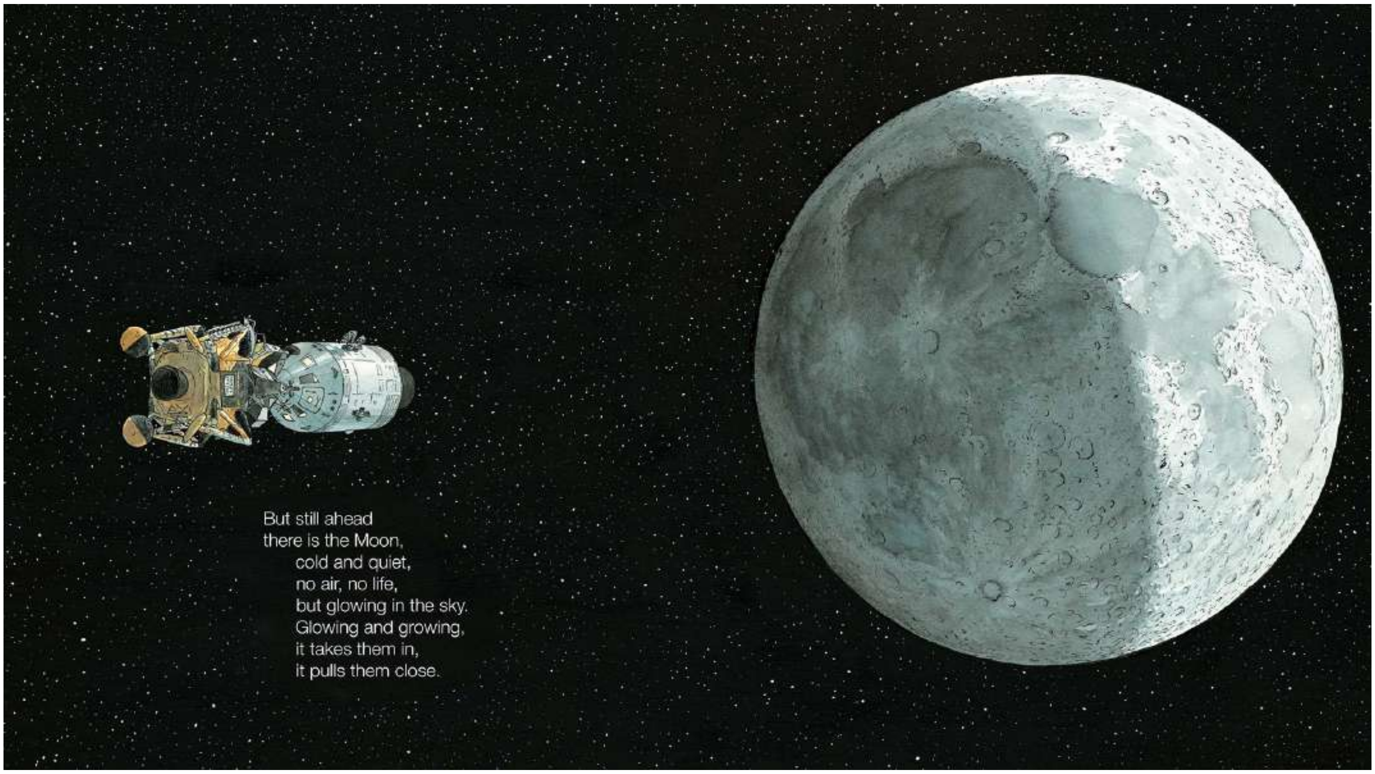


Illustration © Brian Floca

Let's get started!

After reading *Moonshot* together, have a group discussion about the book. Here are some suggestions for questions you can ask to get kids talking:

- What kind of spaceships did the Apollo astronauts need to land on the Moon and safely return to Earth?
- What do you think it felt like when the **Saturn rocket** lifted into the air?
- What did the astronauts experience while they were riding in the spaceship? Why does everything float?
- Some things went wrong during the landing. What did the astronauts do?
- What was it like to walk on the Moon?

Activity 3: Apollo 11 Landing Humans on the Moon

- How do the illustrations in the book help you understand how the astronauts feel?
- The sky looks dark, blank, and starless on the Moon? Can you guess why? Tell the kids that when you see the daytime blue sky on Earth you're seeing sunlight scattering off the air (atmosphere). There's very little atmosphere on the Moon, so nothing to scatter the light, so the sky appears black.
- What do you think everyone who watched the landing felt when they saw a man on the Moon for the first time?
- How might a visit to the Moon change the way you see our planet Earth?
- What do you think it would be like to travel in to space? Would you like to go to the Moon?
- Why is exploring the Moon — and space — important?

Footprints frozen in time

Return to the photo of the footprint. Tell kids that this footprint will be there for millions of years! **Ask kids:** Do you have a theory about why? If the kids are stuck, remind them what they learned about craters and why they never disappear on the Moon — because there is no wind, rain, plants, or animals to erase them. Only a meteor strike could destroy the footprints, and that's not likely!

More activities

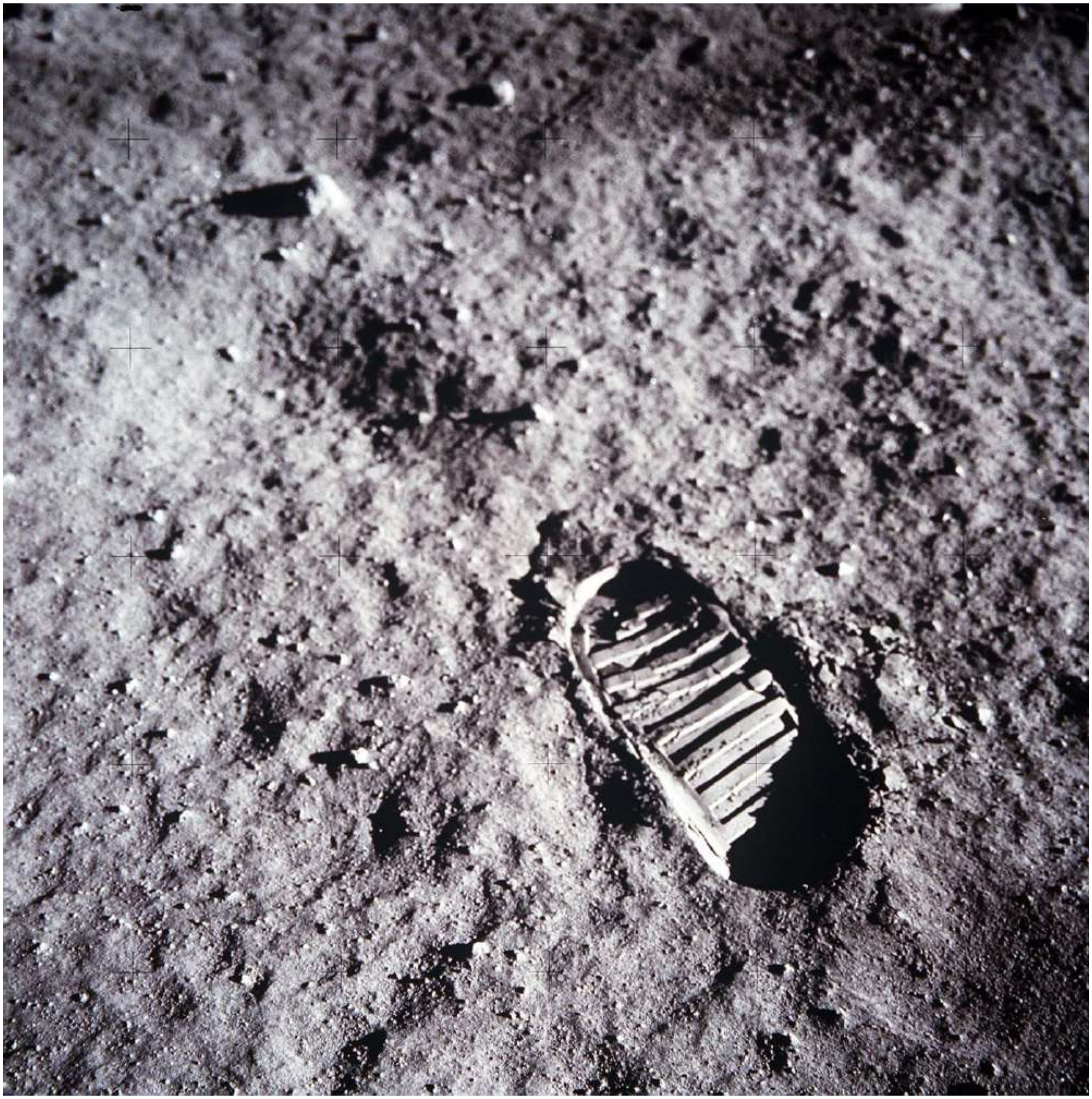
Build a Moon Habitat (NASA Space Place)

https://spaceplace.nasa.gov/moon-habitat/en/

Video: Lunar Lander Challenge (Janet's Planet)

https://www.youtube.com/watch?v=s_jwiFZHEzU&list=UU0J0BQqvNIBBIg5dCwbEnyg

First footprint on the Moon



Apollo 11 astronaut Neil Armstrong's first footprint on the Moon, July 20, 1969
(Photo © NASA)

Activity 4: How High Could You Jump on the Moon?

Introduction

Gravity is an important scientific concept, but one that is difficult to understand, even for adults. Having children use their own bodies to test gravity, and then compare how they would perform against gravity on the Moon is a great jumping off point for understanding that the effects of gravity are different in different parts of our solar system.

Supplies

- Large colored markers
- Measuring tape
- Chart paper, adhesive (PostIt® style) if possible
- Blue masking tape
- Small ball or beanbag (optional)

Get kids thinking

Ask kids: What is gravity? Does anyone know how gravity affects us on Earth? Kids might say: "It's what pulls you back down to Earth when you jump up." Or "It's what keeps us on the ground."

Gravity is a force that "pulls" people and objects towards the ground.

Do you think gravity on the Moon is the same, stronger, or weaker than it is on Earth? After a few guesses, if you can, show them this NASA video of an astronaut jumping on the Moon (https://www.youtube.com/watch?v=g5aPoRtF2vw) and then have them guess again.

The Moon's gravity is weaker than the Earth's — in fact it is 1/6th as strong as on Earth. When you're on the Moon, you are 1/6th as heavy. So if you weigh 75 pounds on Earth, you would only weigh about 12 pounds on the Moon. But your muscles are as strong as they are on Earth, so you can jump 6 times farther!

See Your Weight on Other Worlds: https://www.exploratorium.edu/ronh/weight/

Activity 4: How High Could You Jump on the Moon?

Using the same force of a jump on Earth, you could rise 10 feet off the ground and stay in the air for about 4 seconds.

Here's How High You Could Jump on Other Worlds in The Solar System: https://www.sciencealert.com/here-s-how-high-you-could-jump-on-other-worlds-in-the-solar-system

Let's get started!

Make the jumping chart ahead of time

Tape or stick two pages of the chart paper on the wall, one above the other so that they make one long sheet. The highest point of the top piece should be higher than any of your kids can jump, and the bottom of the lower sheet should be no higher than your shortest child's head. (You may need a third sheet of paper to cover this range.)

Place a long piece of tape alongside the paper and label it with inches, from the floor to the top of the chart paper. This will help you quickly determine how high each student jumped in this activity, rather than having to measure after each jump.

In this jumping challenge, kids will see how high they can jump, and then calculate how high that jump would be on the Moon!

The jumping challenge!

Each child who wishes to try should get a turn to jump. For kids who have difficulty jumping, you can challenge them to throw a ball or beanbag up as high as they can, and measure that distance instead. You can also try a standing long jump, using the masking tape to measure out lengths on the floor.

Activity 4: How High Could You Jump on the Moon?

1. Have a child stand facing the chart paper on the wall, holding a marker.

2. Ask the child to reach his hand over his head, as high as he can, and make a mark on the paper with the marker. This is the child's starting point.

3. Tell the child to take a small step back (no running starts!), bend his knees and jump as high as he can, making a mark on the paper at the highest point.

4. Have the child measure the distance between his starting mark and his jumping mark. This is how high he jumped. Have him write down his measurement.

5. After every child who wants to try has had a turn to jump, have your students calculate how high their jump would have been on the Moon by multiplying their measurement by 6.

For older children, encourage them to do the math on paper. For younger children who have not yet learned how to multiply, you can use a calculator. The resulting Moon jump measurement is how high their feet would be off the ground if they had jumped on the Moon. You can have each child record this height on the paper on the wall, measuring from the floor to their Moon jump measurement.

Ask kids:

- Were you surprised by the results?
- Could anyone jump over their own head on the Moon, or farther than their own height?
- Who jumped the highest/farthest?
- What do they think it would be like to walk on the Moon?
- What would it be like to play basketball, soccer, or another sport?

Reinforce the idea that the reason they can jump higher on the Moon is because gravity is weaker there; and the reason that they can't jump as high on Earth is because gravity is stronger.

Activity 5: Astronaut Glove Box

Introduction

Apollo astronauts have brought back more than 800 pounds of Moon rocks and soil to Earth. We are still studying the rocks and soil to learn more about the origins of the Moon and the Earth. One recent and surprising discovery is that most of the craters on the Moon came from a single, catastrophic event.

A scientist at NASA still remembers handling her first Apollo sample decades ago, wearing three sets of gloves and working in a nitrogen-filled glove box. "Just to pick it up was really exciting," she says, "because I was picking up a piece of the Moon."

Supplies (for each glove box)

- Large cardboard box for examining rocks
- Utility knife (adults only)
- Rubber gloves (small size for small hands)
- Duct tape
- Small plastic bowls (optional)
- Magnifying glass
- Small ruler
- Rocks of various sizes and shapes
- Plastic wrap
- Clipboard and paper
- Pen or pencil

Moon rock from Apollo 14 mission, 1971 © NASA

Get kids thinking

We didn't know anything about the Moon rocks when we first collected them. Could they cause disease in humans or be dangerous in some other way?

Activity 5: Astronaut Glove Box

Scientists who study the Moon rocks use a special sealed glove box to handle, measure, and perform tests. **Ask kids:** Why do you think it is important to use a glove box?

Using a sealed box keeps human hands away from objects that may be harmful to us, and it also protects objects that may be damaged if touched directly by human hands.

Scientists living and working on the International Space Station also use glove boxes for all kinds of experiments in space. Here's a photograph of Commander Peggy Wilson doing a study on bone cells:

Destiny Lab on the International Space Station © NASA

Activity 5: Astronaut Glove Box

Let's get started!

In this activity, kids will get a chance to examine "Moon rocks" using a glove box, and record what they observe.

Adults can build the glove box ahead of time, or if you have a small group you can let the kids help with the construction.

Step one should be done by adults only: First, cut the lid flaps off of the cardboard box. Then cut two round holes on both sides of the box — holes large enough for kids to fit their hands through but small enough that you can tape the gloves to them (see next step).

Place the gloves through the holes you've cut, and position them for little hands — and make sure to put the left glove in the left hole and the right glove in the right hole! Tip: If you point the thumbs inwards and slightly up the hand position will feel more natural to the kids.

Use duct tape to form a complete seal on the outside of the box where the gloves went in. **Ask kids:** why is a complete seal so important to scientists and astronauts?

Fill the box with rocks, magnifying glass, and the optional small plastic bowls (for sorting rocks into categories by size, color, roughness, etc.).

Cover the top of the box with plastic wrap and seal with duct tape.

Have kids observe the rocks feel the rocks with their hands, measure the rocks, and sort into the bowls. While two kids are manipulating the rocks, two other kids can be taking notes about what their lab partners are seeing in the glove box. Then switch places.

© GiftofCuriosity.com

Writing About the Moon

Writing helps kids process and solidify new knowledge and gives them an opportunity to use new vocabulary and concepts. Offer one or more of these prompts or questions to get your Space Rangers writing.

Spin a tall tale

Tall Tales feature a larger-than-life, or superhuman, main character who solves a problem in a funny and fantastical way.

Ask kids: have you read any Tall Tales or know any Tall Tale characters? How about Paul Bunyan, huge lumberjack who eats 50 pancakes in one minute and dug the grand canyon with his axe.

You might want to read a Tall Tale so kids can become familiar with that kind of story. Here are a few we recommend:

- *Paul Bunyan* by Steven Kellogg
- *Sally Ann Thunder Ann Whirlwind Crockett* by Steven Kellogg
- *American Tall Tales* by Mary Pope Osborne
- *John Henry* by Julius Lester
- *Swamp Angel* by Anne Isaacs

In this writing activity, kids will spin a tall tale about a conquering hero or heroine on a new frontier — the Moon! Even though a tall tale isn't true, the story should be told as if your hero's adventures really happened. Remember what you have learned about the Moon so you'll have some interesting facts to exaggerate!

Option: Kids can develop their Tall Tale as a comic strip.

Writing About the Moon

Imagining the lunar landscape

Look at the photo of the lunar landscape (see page 76). Select one of the places on the Moon that sounds interesting to you. Sea of Rains? Ocean of Storms? Archimedes? Imagine what it would be like to be there. Think about how the air feels, what colors you see, what the landscape features feel like.

Write a **cinquain poem** about your lunar landscape.

Cinquain (pronounced sin-cane) is a five-line poem that uses descriptive words about the natural world. A cinquain poem doesn't rhyme. The structure for a cinquain looks like this:

Line 1: One word title, a noun that identifies your topic

Line 2: Two adjectives that describe your topic

Line 3: Three "ing" verbs that describe action

Line 4: A phrase that describes something about your topic

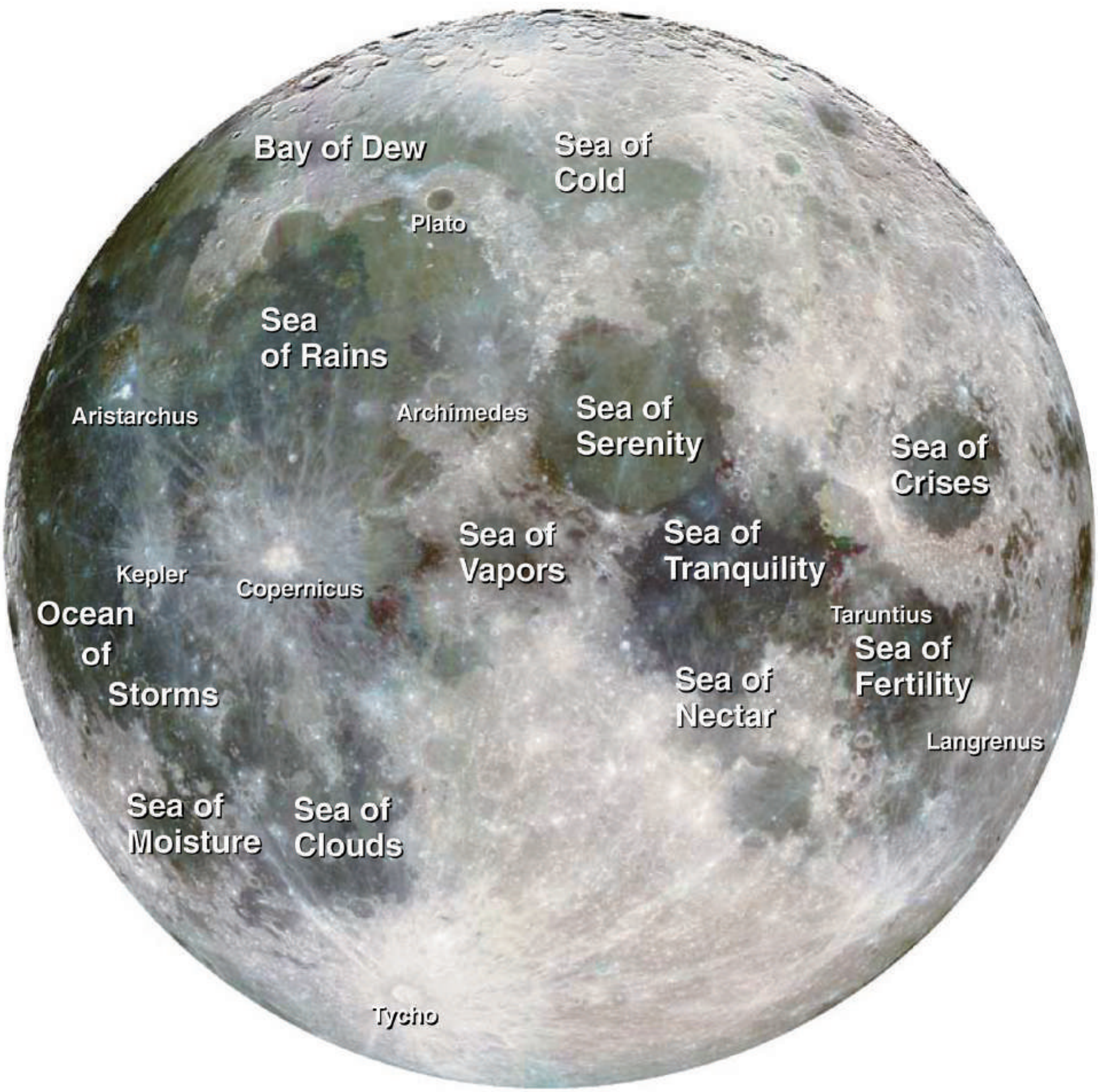
Line 5: A noun that is a synonym or another way to name your topic

Example:

tree
white, tall
reaching, bending, fluttering
leaves and twigs in the wind
aspen

Option: Write a descriptive paragraph about your place in the lunar landscape. Use interesting words! Add a drawing of what your lunar landscape looks like.

The lunar landscape



Writing About the Moon

Design a Moon mission patch

Did you know? A unique patch is designed for every NASA mission!

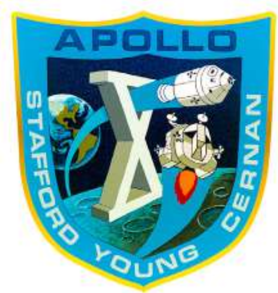
Following the tradition set by earlier missions, astronauts Neil Armstrong, Buzz Aldrin and Michael Collins — the **Apollo 11** crew — were given the task of designing their mission patch. This patch was important because the mission was so historic!

Here's the patch they designed:

The eagle represents both the United States and the **Lunar Module** and the olive branch is there as a symbol of peace.

Writing About the Moon

Here are more examples of NASA mission patches:



Tell kids to imagine that they are astronauts going on a new mission to the Moon — Apollo 18. Their challenge is to design their own mission patch.

Encourage kids to think about the elements they want on the patch and what they mean. Have kids make a few sketches, then choose their final idea and draw the patch in pencil first, then fill in with color.

Blank templates are provided on the next page.

Space mission patch design

Kid-friendly Websites and Apps

Websites

Video: Story Time from Space
https://storytimefromspace.com/

Video: Moon 101 (National Geographic)
https://video.nationalgeographic.com/video/101-videos/00000164-b3ea-d247-ab67-b7e-a483e0000

Video: Apollo 11, The First Moon Walk (National Geographic Kids)
https://www.youtube.com/watch?v=CbTaDOuSePk

The Moon Landing (National Geographic Kids)
https://kids.nationalgeographic.com/explore/history/moon-landing/

Earth's Moon: interactive map of the Moon (NASA)
https://moon.nasa.gov/

Moon Trek (Jet Propulsion Lab)
https://trek.nasa.gov/moon/

International Observe the Moon Night (NASA)
https://moon.nasa.gov/observe-the-moon/annual-event/overview/

Lunar Tunes (NASA)
https://moon.nasa.gov/galleries/lunar-tunes/infographic/

Video: Lunar Eclipse (NASA)
https://apod.nasa.gov/apod/ap190120.html

Apollo Program (Smithsonian National Air and Space Museum)
https://airandspace.si.edu/explore-and-learn/topics/apollo/apollo-program/

Historic Space Suits (NOVA)
https://www.pbs.org/wgbh/nova/space/historic-space-suits.html

Kid-friendly Websites and Apps

Educational apps

NASA (Apple)
https://www.commonsensemedia.org/app-reviews/nasa

Solar System Explorer (Android)
https://www.commonsense.org/education/app/solar-system-explorer

Britannica Kids: Solar System (Apple) $
https://www.commonsensemedia.org/app-reviews/britannica-kids-solar-system

Solar System (Apple) $
https://www.commonsensemedia.org/app-reviews/solar-system-for-ipad

This is my Spacecraft – Rocket Science for Kids (Apple) $
https://www.commonsensemedia.org/app-reviews/this-is-my-spacecraft-rocket-science-for-kids

Simple Rockets (Android, Apple) $
https://www.commonsensemedia.org/app-reviews/simplerockets

Bean Bag Kids Apollo 11(Apple) $
https://www.commonsensemedia.org/app-reviews/bean-bag-kids-apollo-11

Day 4

Mars: The Red Planet

Day 4

Mars: The Red Planet

Introduction

Let's explore one of the planets that has really captured our imaginations: **Mars**. Mars has been known since ancient times because you can see it without a telescope. The **planet** is covered in rocks and sand, colored red by **iron oxide**. Mars has **volcanoes**, though they are not active. We once thought there might be life on Mars, but space **orbiters**, **landers**, and **rovers** have revealed a cold **desert** world. Scientists are still looking for clues that would tell us if Mars has (or once had) the right conditions to support even small life forms, called **microbes**.

Questions to guide explorations and experiments

- Why is Mars called the Red Planet?
- What do we know about volcanoes on Mars? What happens when a volcano erupts?
- What kinds of spacecrafts have landed on Mars? How do space engineers get them to land without crashing? How do the Mars rovers move around?
- What if humans traveled to Mars? What would we need to bring in order to survive?
- If we met a Martian, what would it look like?

Books and activities

- **Books:** fiction, nonfiction and poetry all about the planet Mars, how rovers explore Mars, and whether there is life on the Red Planet.
- **Activities:** explore the surface of Mars (including volcanos!), learn about Mars rovers, invent your own Martian, and write a Journey to Mars travel guide.

Children's Books

Fiction

- *The Boy Who Went to Mars* by Simon James (Ages 4-8)
- *The Countdown Conspiracy* by Katie Slivensky (Ages 9-12)
- *Life on Mars* by Jon Agee (Ages 4-8)
- *Luciana: Out of This World* by Erin Teagan (Ages 9-12)
- *Max Goes to Mars* by Jeffrey Bennett (Ages 6-9)
- *Mousetronaut Goes to Mars* by Mark Kelly (Ages 4-8)
- *Mr. Wuffles* by David Wiesner (Ages 4-8)
- *The Truth About Martians* by Melissa Savage (Ages 9-12)
- *The Way Back Home* by Oliver Jeffers (Ages 4-8)
- *There Was an Old Martian Who Swallowed the Moon* by Jennifer Ward (Ages 4-8)

Poetry

- *Comets, Stars, the Moon, and Mars: Space Poems and Paintings* by Douglas Florian (Ages 6-9)
- *Out of This World: Poems and Facts About Space* by Amy Sklansky (Ages 6-9)

Nonfiction

- *Curiosity: The Story of the Mars Rover* by Markus Motum (Ages 9-12)
- *Destination Mars* by Seymour Simon (Ages 6-9)
- *Exploring Space: From Galileo to the Mars Rover and Beyond* by Martin Jenkins (Ages 9-12)
- *Mars: Our Future on the Red Planet* by Leonard David (Ages 9-12)
- *The Mighty Mars Rovers* by Elizabeth Rusch (Ages 9-12)
- *Mission: Mars* by Pascal Lee (Ages 9-12)
- *Mission to Mars* by Franklyn Branley (Ages 4-8)
- *National Geographic Kids: Mars* by Elizabeth Carney (Ages 6-9)
- *The Rocket that Flew to Mars* by Audrey Sauble (Ages 4-8)
- *Welcome to Mars: Making a Home on the Red Planet* by Buzz Aldrin (Ages 9-12)
- *You Are the First Kid on Mars* by Patrick O'Brien (Ages 6-9)

Space Words

Atmosphere
The layer of gases surrounding Mars, Earth, and other planets, held in place by gravity.

Canyon
A deep valley with steep sides.

Crater
A bowl-shaped cavity caused by an asteroid impact.

Curiosity, Spirit, and Opportunity
Three car-sized Mars rovers designed to collect information about the Red Planet. Curiosity was launched November 26, 2011 and is still active.

Desert
A very dry area with little or no rainfall to support plant life.

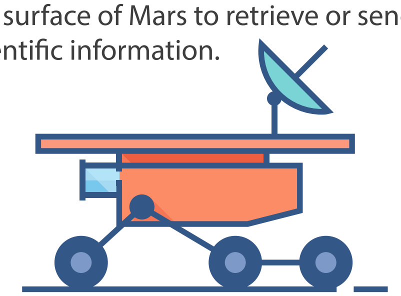
Gravity
A force that pulls matter together; a force that pulls people and objects toward the ground.

Iron Oxide
A substance formed when iron mixes with oxygen and water. Also called rust, it is red in color.

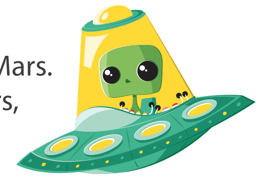
Lander
A type of spacecraft that is designed to land on the surface of a planet, comet, or moon, to retrieve or send scientific information.

Mars
The fourth planet from the Sun. It is the second smallest planet in the solar system, and is about half the size of Earth. Often called the Red Planet.

Mars Rover
A space vehicle designed to travel on the surface of Mars to retrieve or send scientific information.



Martian
A fictional creature from the planet Mars. Also, something from the planet Mars, such as Martian soil.

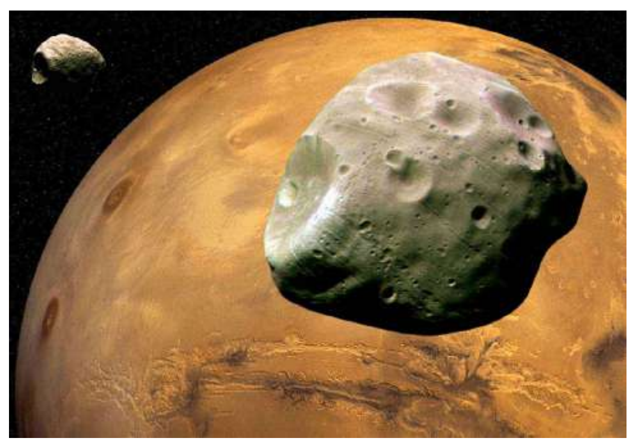


Microbe
A life form that can only be seen with a microscope. Bacteria and viruses are microbes.

Orbiter
A spacecraft designed to move around (orbit) a planet or moon.

Olympus Mons
The largest volcano in the solar system and located on Mars. It is almost 3 times taller than Mt. Everest!

Phobos and Deimos
The two small, rocky moons orbiting around Mars; they look like asteroids.



Polar ice cap
Dome-shaped sheets of ice found at the north and south areas (polar regions) of a planet.

Terrestrial
Earth-like. A terrestrial planet has a solid rocky surface, with metals deep in its core.

Volcano
A hole (vent) in a planet's surface that releases lava (melted rock) and gases to the surface.

Activity 1: Why Is Mars Red?

Introduction

The soil (dust) on **Mars** contains iron, one of the elements found in nature. People have used iron to make things like tools and weapons for more than 3,000 years.

Astronomers believe that Mars once had liquid water and it has a tiny amount of oxygen. When iron mixes with water and oxygen, it produces **iron oxide**, or rust.

Rust is reddish brown in color. That's where Mars gets its name, the Red Planet, because it's soil is full of iron turned to rust.

Supplies

- Photograph of the Martian landscape (provided)
- Two jugs of water
- Small tray filled with 1-2 cups of light-colored sand
- Rusty nail or other rusty object
- Pens, pencils
- Crayons and/or colored pencils

Plain steel wool pads look like this:

Work in teams of 2-3 kids. For each team:

- Plastic container or small tray
- About 1 cup of light-colored sand
- 1-2 **plain steel wool pads** (do NOT use soap pads or stainless steel pads)
- Worksheet to record observations (one for each child, see the template on page 87)

This experiment takes 3 days to complete

Get kids thinking

Mars is sometimes called the Red Planet because of the color of its soil. How did the soil become red or rusty colored. Have you ever seen a rusty object — maybe the handlebars on your bike or an old nail you found in your neighborhood. **Ask kids:** Do you have any ideas about why the metal turned rusty?

Activity 1: Why Is Mars Red?

Explain to the kids that water is the culprit! When water (from rain, for example) mixes with air (oxygen) and the iron in your bike handlebars or a nail, a chemical reaction starts. That chemical reaction changes iron to iron oxide, or rust. The color of your handlebars will turn from silver to rusty red or rusty brown. That's what happened on Mars.

Iron + Oxygen + Water = rust

In this activity, kids will be creating their own Martian soil.

Let's get started!

Give each pair of kids a container with sand. Also give them 2-3 pads of steel wool, which you've pulled apart. Explain that the sand represents the soil on Mars. Have the kids put the steel wool in the container and mix the sand and steel wool.

Go around the room with the water jugs and pour a little water into all the containers. The sand and the steel wool should be very damp, but there shouldn't be a layer of water in the container.

Tell the kids that they will be observing their sand over 3 days. Ask the kids to record what they see each day, in words and pictures. Give each child their own worksheet.

Create two "controls" for the experiment: (1) an extra tray filled with sand and steel wool, but NO water; and (2) and extra tray filled with sand and enough water to moisten the sand but NO steel wool. Kids will compare the controls with their own containers to observe the difference that water and steel wool make in creating the rusty soil.

On days 2 and 3, add a bit of water to each child's tray and control #2 to keep the sand from drying out.

Ask kids: What happened during the experiment? Did the sand turn red? Why? If none of the theories are right, tell the kids that the steel wool contains iron and when mixed with water and air the iron starts to rust. The rust mixes with the sand to turn the whole mixture reddish-brown.

Activity 1: Why Is Mars Red?

Explain that there is a lot of iron in the ground on Mars. That is why we see Mars as a red planet. Pass the rusty nail around the class, so that the children get an idea of what rust looks like on 'real' objects, and what it feels like. **What else rusts?** Encourage the kids to think of other things that can rust.

Photo © First Grader At Last

More activities

Video: Why Is Mars Red? (Mystery Doug)
https://www.youtube.com/watch?v=eAj_f6JjOUo

Why Is Mars Red? The Martian Soil Experiment

My name: ___________________________

Day 1

Describe what the sand looks like:

Draw what the sand looks like:

Day 2

Describe what the sand looks like:

Draw what the sand looks like:

Day 3

Describe what the sand looks like:

Draw what the sand looks like:

Activity 2: Eruption! Olympus Mons, the Mars Volcano

Introduction

Mars has the largest **volcano** in our solar system! Astronomers believe that the volcano called **Olympus Mons** last erupted 25 million years ago, and that it may still be an active volcano. Olympus Mons is as big around as the state of Arizona (about 400 miles) and rises 16 miles above the Martian surface — almost three times taller than Mt. Everest.

Get kids thinking

Volcanoes can be found on Earth, but did you know that there are volcanoes all around our solar system? Io, one of the large moons orbiting around Jupiter, is covered with active volcanoes, and scientists have found evidence of volcanoes on our Moon as well as the moons of Saturn and Neptune.

Ask kids: Have you ever watched a movie of a volcano eruption? What does it look like? Describe what is coming out of the top of the volcano. What would the air feel like if you got too close to a volcano? What sounds might you hear?

Images from Mars **orbiters** and **rovers** show us what **Olympus Mons** looks like.

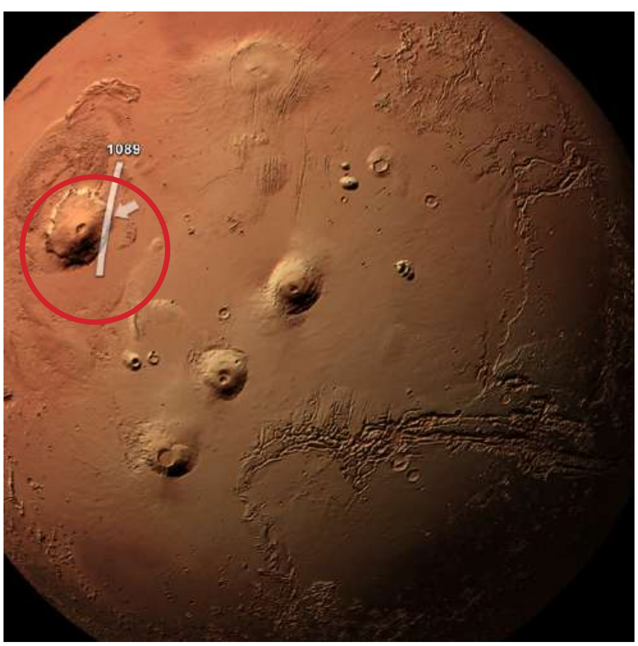


Photo © NASA. Olympus Mons shown in red circle

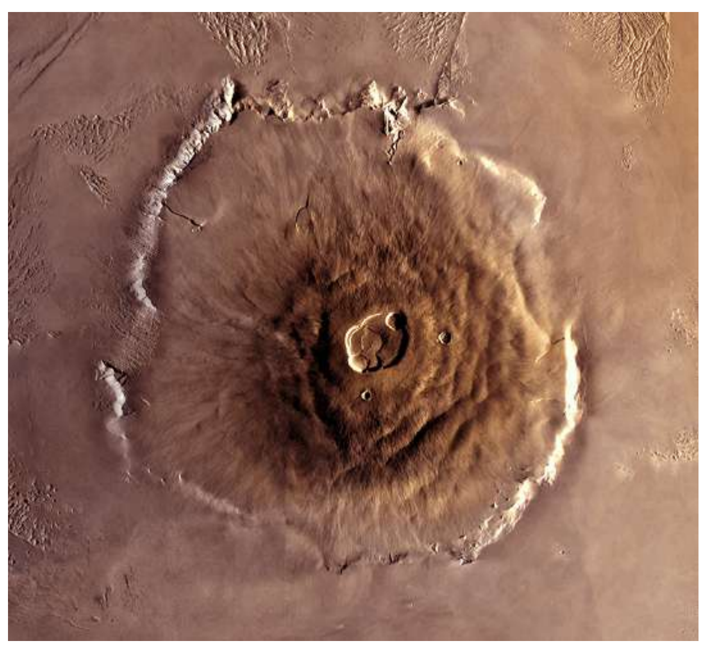


Photo © NASA. Olympus Mons seen from above

Activity 2: Eruption! Olympus Mons, the Mars Volcano

Supplies

- Deep baking dish
- 2-liter plastic bottle
- Large mixing bowl
- Spoon(s) for mixing
- Drop cloth or place where volcano can erupt and make a mess

For the volcano "cone"

- 6 cups flour
- 2 cups salt
- 2 cups warm water (more if needed)
- 4 tablespoons cooking oil
- Food coloring: mixture of red and black to make brown (optional)

For the volcano "lava"

- Hot tap water
- Funnel
- 2 tablespoons baking soda
- 2 cups white vinegar
- Red food coloring (optional)
- 6 drops of dish detergent
- Smart phone to videotape eruption (optional)

Activity 2: Eruption! Olympus Mons, the Mars Volcano

Let's get started!

First, make the "cone" of the volcano

Mix 6 cups flour, 2 cups salt, 4 tablespoons cooking oil, and 2 cups of water. Add food coloring to make the dough brown, if you like. The resulting mixture should be smooth and firm (add more water if needed).

Then, stand the soda bottle in the baking pan and mold the dough around it into a volcano shape. Don't cover the hole or drop dough into it.

Now for the lava!

Fill the soda bottle most of the way full with warm water and a bit of red food coloring. Next, add 6 drops of detergent to the bottle contents. The detergent helps trap the bubbles produced by the reaction so you get better lava. Then add 2 tablespoons of baking soda to the liquid.

Slowly pour vinegar into the bottle. Watch out — eruption time!

You can make your volcano erupt over and over by adding more baking soda. Pour in more vinegar to trigger the reaction. You may need to pour off some of the "lava" between eruptions.

Activity 2: Eruption! Olympus Mons, the Mars Volcano

Ask kids: what's happening? The cool red lava is the result of a chemical reaction between the baking soda and vinegar. Carbon dioxide gas is produced, which is also present in real volcanoes. As the carbon dioxide gas is produced, pressure builds up inside the plastic bottle, until the gas bubbles out of the volcano.

Instead of water bubbling out, when a volcano erupts, hot melted rock gets pushed out. Share the infographic on the next page that shows how a volcano erupts. If you have Internet access, you can also watch videos of volcano eruptions.

Volcanoes 101 (National Geographic) shows videos of real volcanic eruptions and lava flow, as well as an animation explaining how and why volcanoes erupt.

https://video.nationalgeographic.com/video/101-videos/00000144-0a2c-d3cb-a96c-7b2d221d0000

More activities

Video: DIY Volcano (PBS Parents)

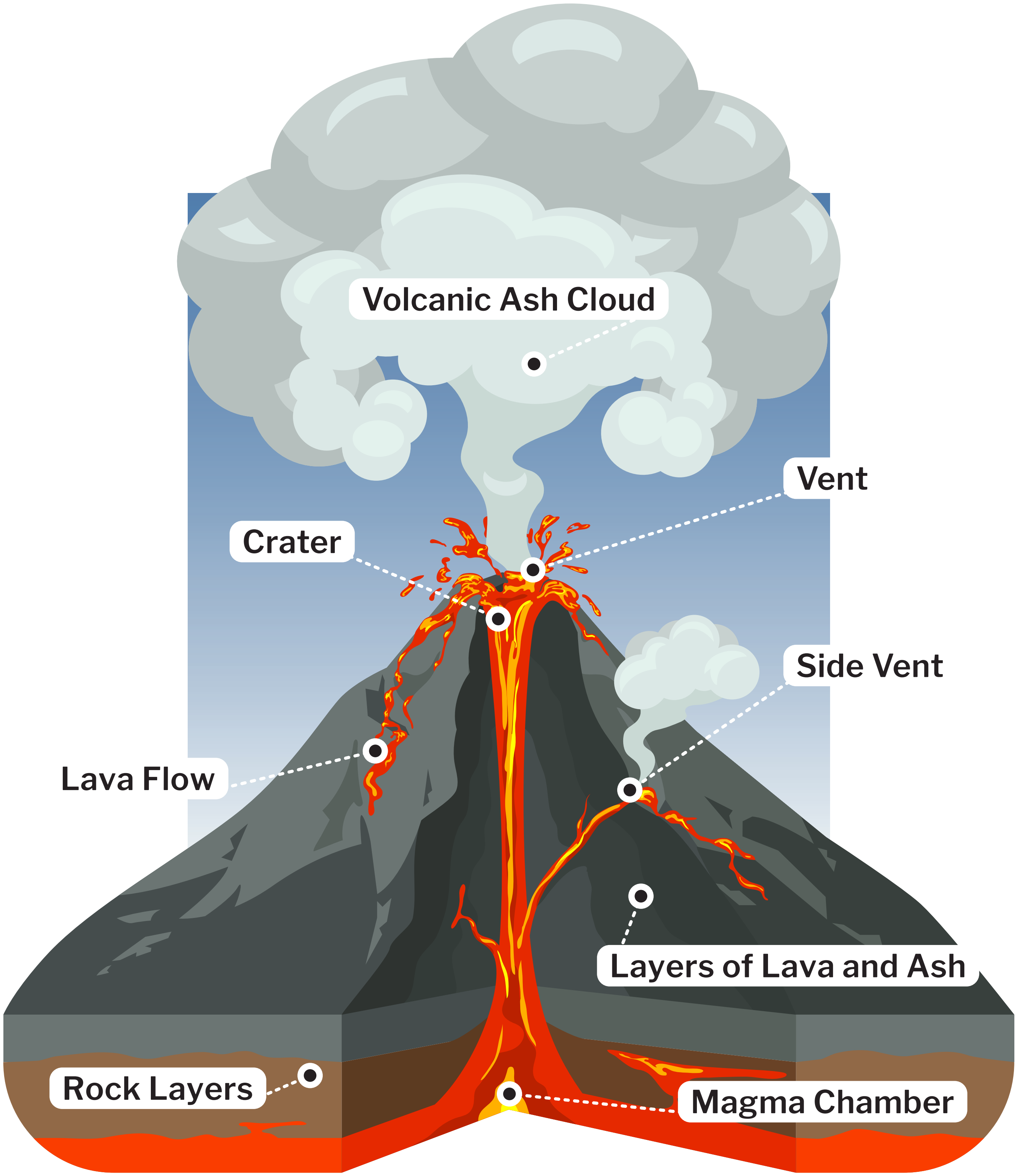
http://www.pbs.org/parents/crafts-for-kids/diy-volcano/

Space Volcanoes! (NASA Space Place)
https://spaceplace.nasa.gov/volcanoes/en/

Explore Volcanoes (National Geographic Kids)
https://kids.nationalgeographic.com/explore/youtube-playlist-pages/youtube-playlist-volcano/

Diagram of a Volcano Eruption

4



Activity 3: Landing on Mars

Introduction

To learn about the Red Planet, our NASA scientists and engineers have sent **landers** and **rovers** to the surace of Mars. So far, the U.S. has had eight successful Mars landings.

Imagine this: your rover is approaching Mars, going at high speed and you need to land it gently on the surface of the Red Planet, with the spacecraft and all of its equipment safe and sound. The **atmosphere** on Mars is very thin, so it doesn't help slow the rover down much.

Supplies (for each child)

- Heavy weight paper or card stock cut into 8-inch triangle (see template on page 96)
- Hole puncher
- 2 large paper clips
- 4 lengths of string, each 18-24 inches long (longer strings for a higher drop point)
- 12" x 12" piece of newspaper
- 12" x 12" piece of cloth
- 12" x 12" piece of plastic wrap or plastic trash bags
- Adhesive tape or packing tape
- Consistently-sized small plastic toy vehicles, crayons, or larger rubber erasers
- Stopwatch, clock with a second hand, or timer on cell phone
- Notepad, pen or pencil

Get kids thinking

Engineers at NASA have explored many new ways to slow down the landers for a safe arrival.

Ask kids: can you think of anything that might slow down a Mars lander to make it safe for landing? A parachute does the trick! It opens up after the lander enters the Mars atmosphere, catches air as it floats, creating drag (working against the downward pull of **gravity**) — that slows down the landing.

Activity 3: Landing on Mars

If you have Internet access, watch this video from NASA and the Jet Propulsion Lab (JPL), **We Brake for Mars**: https://www.youtube.com/watch?v=9h1NtQJ59kM

NASA and JPL are testing a supersonic parachute under Mars-like conditions for future exploration.

Ask kids: have you ever seen a parachute in action? What did you observe?

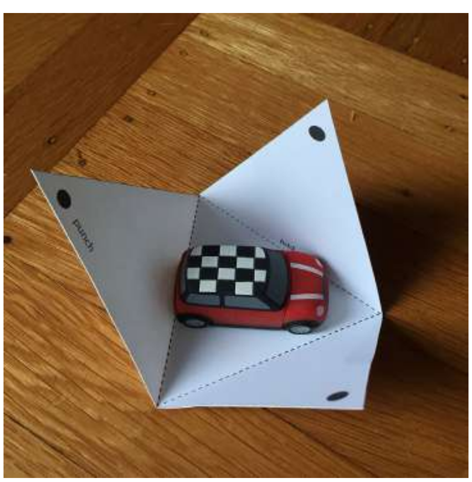
Let's get started!

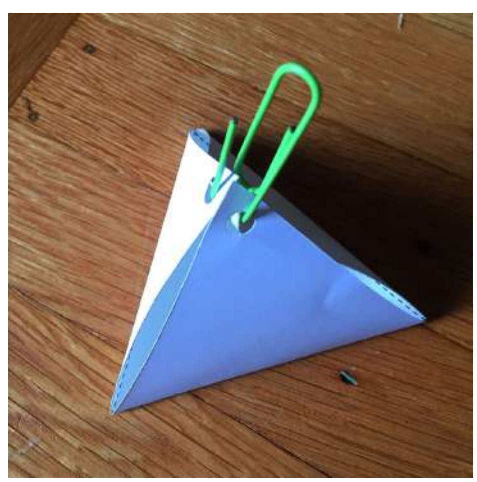
In this challenge, kids will explore which material makes the best parachute for a slow, soft landing of their Mars lander.

Recommended: Have an adult demonstrate how to assemble the "lander" and then attach the test parachute. It's best to do this activity on a day that isn't windy.

First, build the lander with the triangle cut from heavy weight paper. Take one of the triangle corners and fold it over so that its point is in the middle of the triangle's other side. Crease the fold well, then unfold it. Repeat with the two remaining corners. Use the hole punch to create one hole near the tip of each point. This is your lander!

Next, place the small toy vehicle, crayon or large eraser (the "payload" or scientific equipment) in the lander. Insert the paper clip through the three punched holes to form a little carrier.





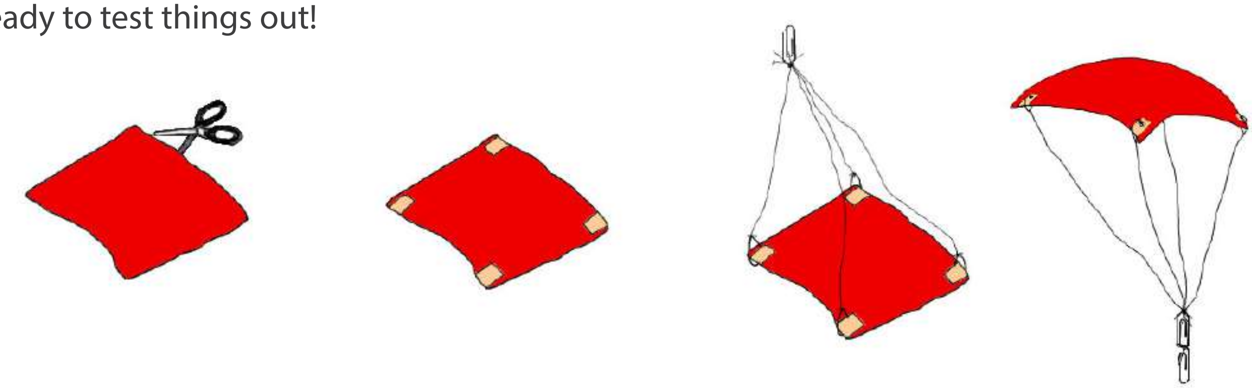
Activity 3: Landing on Mars

Then, gather the four strings and tie together in a knot at one end. Attach a large paper clip to the knotted end.

The newspaper, cloth, and plastic wrap are your test parachutes. **Ask kids:** predict which material will create the slowest landing and write it down in your notepad.

Have kids choose one material for the first test run and tape the ends of each string to a corner of the test parachute — being careful not to tangle up the strings.

Finally, attach the lander to the parachute by interlocking the two paper clips. Now you're ready to test things out!



Find a high place — stairwell, balcony, edge of a deck — to toss your lander and time it to see how long it takes to reach the ground. Record the observations in your notepad.

Repeat with the two other parachute materials.

Ask kids: Which parachute slowed down the lander the most? Is that what you predicted? What other materials might make a better parachute and why?

Option B: You can also do this experiment using raw eggs in the lander, instead of plastic toy vehicles, crayons, or erasers. This will also test how soft the landings really are! Warning: it can get messy, so use a dropcloth to catch any broken eggs.

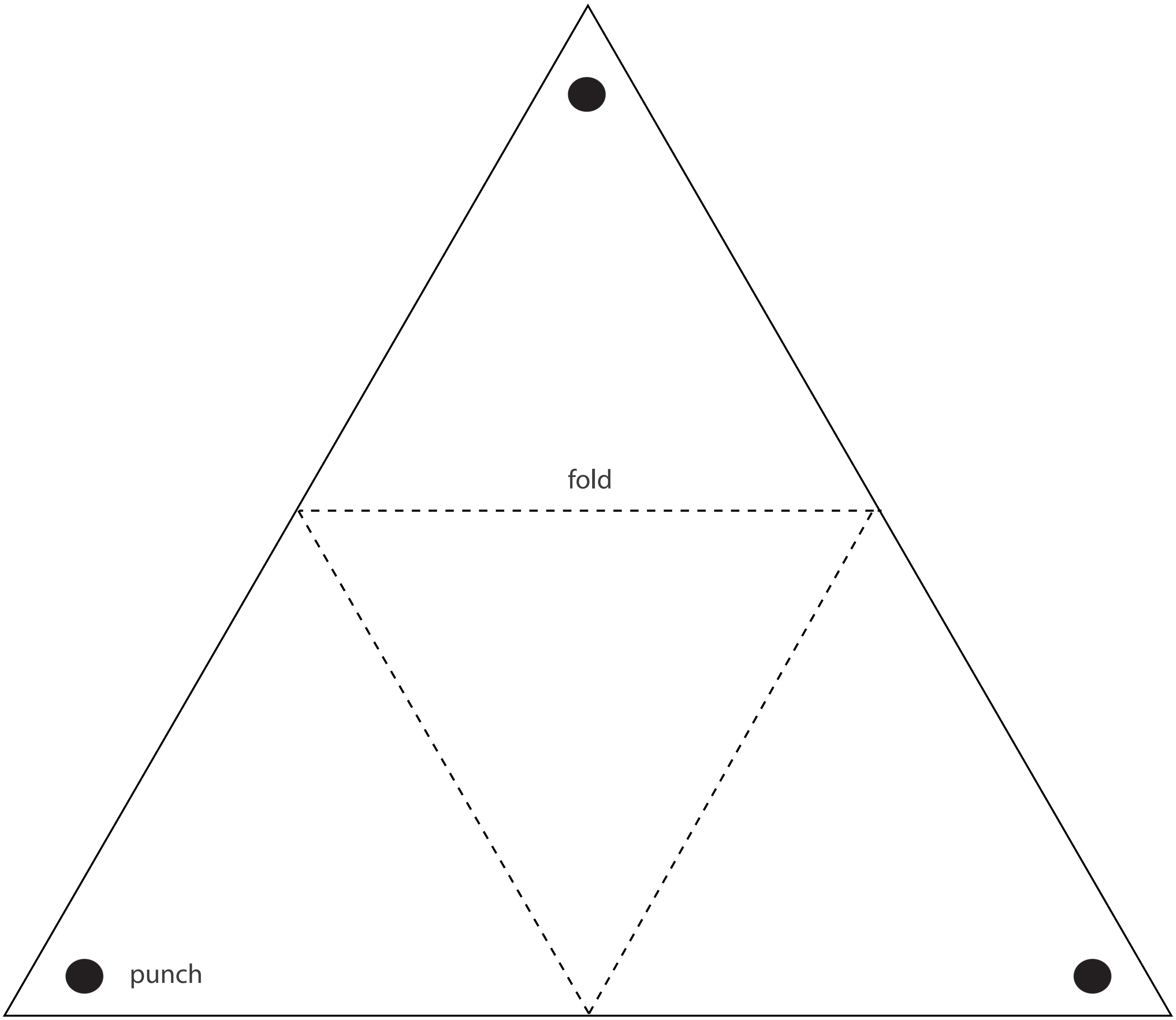
More activities

Egg Drop Challenge (Buggy and Buddy)
https://buggyandbuddy.com/egg-drop-challenge-free-planning-printable-2014/

Design Squad: Soft Landing (PBS Kids)
https://pbskids.org/designsquad/build/soft-landing/

Mars Lander Template

4



Activity 4: Create a Martian!

Introduction

Do **Martians** exist?

An early 20th Century American astronomer named Percival Lowell believed that there was intelligent life on Mars — not just **microbes** or plants. He claimed that canals seen on Mars were built by Martians to move water from the **polar ice caps** to the dry areas on Mars in order to grow plants.

When the U.S. spacecraft Mariner 4 flew past Mars in 1965, it took pictures that showed Lowell's theory to be false. But the fascination with Martians and imagining what they might be like is still strong! Many science fiction stories explore the possibility of Martians and what they would be like. Now, many people use the word Martian to mean any alien creature.

Supplies

- White and colored paper
- Colored pencils, markers, or crayons
- Googly eyes, pipe cleaners, felt scraps, glue (optional)
- Large piece of brown kraft paper (you can cut up old grocery bags and tape them together)
- Tape
- Scissors

Get kids thinking

In this activity, kids will create their own Martian — a life form that could survive on Mars. Read a nonfiction book together about Mars, and talk about what the weather and land forms are like.

Ask kids: Is Mars hot or cold? How do animals adapt to live in very cold or very hot climates? Is Mars windy, dusty, rocky? Does it rain on Mars? What if Martians lived in special spaceships?

Activity 4: Create a Martian!

Let's get started!

Have the kids draw, color and embellish their Martians, thinking about the Mars environment as they create their character.

Once they are done, asks the kids to cut their Martian drawing out of the sheet of paper. The kids can add googly eyes and pipe cleaners with glue (optional).

Tape everyone's Martians to a wall covered with brown kraft paper (that's your Mars surface)

Get everyone together in a group, and encourage the kids to talk about their ideas for their Martian. **Ask kids:** what makes your Martian able to live on Mars?

Writing About Mars

Writing helps kids process and solidify new knowledge and gives them an opportunity to use new vocabulary and concepts. Offer one or more of these prompts or questions to get your Space Rangers writing.

Journey to Mars travel guide

The journey from Earth to Mars takes about 6 months or longer. What will you need to pack on your trip to get there? What kind of gear will you need when you get there?

What is different on Mars compared with Earth?

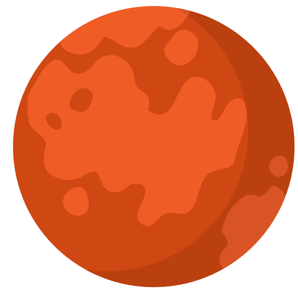
- There's less gravity so you weigh less and would float (If you weigh 65 lbs on Earth, your weight on Mars would be 24 lbs).
- It's cold and can be windy and dusty.
- There's no oxygen to breathe.
- There's no food on Mars.

More questions about going to Mars:

- Where would you get water?
- What's there to see on Mars?
- What will you do on Mars?
- How will you travel around?
- Where will you live?
- What will you do on the long journey back to Earth?

You can have the kids use the template provided on the following 4 pages or create your own design.

If you have Internet access, watch *Max Goes to Mars*, a story read by astronauts from the International Space Station!
https://storytimefromspace.com/max-goes-to-mars-2/



My Trip to Mars

My Trip to Mars

The Journey from Earth to Mars takes 6 months or longer

Each day you need to eat, exercise, sleep, perform tests on equipment, clean the spaceship, and perform experiments. Plan your day during your trip to Mars.

Time of Day	Activity

Getting around Mars

We've sent rovers to Mars — car-sized vehicles that can move around the Mars surface and take pictures and collect samples. The Curiosity Rover is still on Mars today!

Design your own Mars rover.

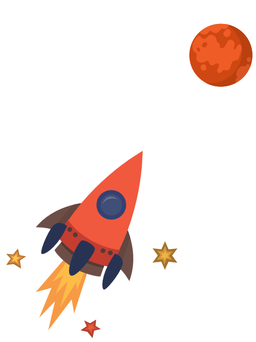
My Trip to Mars

Studying Mars

What do you want to learn about Mars? Will you collect Mars rocks and conduct experiments?

Living on Mars

Mars is cold, dry, and dusty and there's no water or food. Describe how you will survive while you are staying on Mars.



Kid-friendly Websites and Apps

Websites

Video: Mars in a Minute (JPL)
https://www.jpl.nasa.gov/edu/teach/activity/mars-in-a-minute/

Video: Mars 101 (National Geographic)
https://video.nationalgeographic.com/video/101-videos/00000163-92eb-dc54-a7e7-b2ff-da4c0000

Send a Postcard to Curiosity (NASA)
https://mars.nasa.gov/msl/participate/postcard/

Curiosity Mission (NASA)
https://mars.jpl.nasa.gov/msl/

The Mars Rovers (NASA Space Place)
https://spaceplace.nasa.gov/mars-rovers/en/

Mars Rover Game (NASA)
https://mars.nasa.gov/gamee-rover/

The Mars Rovers (NASA Space Place)
https://spaceplace.nasa.gov/mars-rovers/en/

Mars (Dragonfly TV, PBS)
https://www.pbslearningmedia.org/resource/9d8481ab-ad37-4386-9a38-1681654f2fa5/9d8481ab-ad37-4386-9a38-1681654f2fa5/#.XJP3bLh7ncs

Mars (NASA) You can check today's weather on Mars!
https://mars.nasa.gov/

Adventure to Mars online game (NASA Space Place)
https://spaceplace.nasa.gov/mars-adventure/en/#

Kid-friendly Websites and Apps

Imagine Yourself on Mars (Exploratorium)
http://www.exploratorium.edu/mars/activities.php

Mars Trek (NASA)
https://trek.nasa.gov/mars/

Experts discuss plans for sending astronauts to Mars in 20 years (Newsela)
https://newsela.com/read/mars-exploration/id/15852/

Liquid Water Found on Mars (NOVA)
https://www.pbs.org/wgbh/nova/video/liquid-water-found-on-mars/

Educational apps

Be a Martian (NASA)
https://itunes.apple.com/us/app/nasa-be-a-martian/id543704769?mt=8

NASA (Apple)
https://www.commonsensemedia.org/app-reviews/nasa

Solar System Explorer (Android)
https://www.commonsense.org/education/app/solar-system-explorer

Britannica Kids: Solar System (Apple) $
https://www.commonsensemedia.org/app-reviews/britannica-kids-solar-system

Solar System (Apple) $
https://www.commonsensemedia.org/app-reviews/solar-system-for-ipad

Mars Game (Apple)
https://itunes.apple.com/us/app/mars-mars/id1108964305?mt=8

Mars Globe (Apple)
https://itunes.apple.com/us/app/mars-globe/id324185998?mt=8

Day 5

Space Exploration

Day 5
Space Exploration

Introduction

People have been observing what's out there in space since before recorded history. **Astronomers** first focused their eyes and then their **telescopes** on stars, comets, and planets. But to really get out there and look around, a practical way to escape the Earth's **gravity** had to be invented.

Advancements in rocket technology made leaving the Earth, to better understand it and our place in the solar system, possible. The ability to **accelerate** objects to the **velocity** needed to escape Earth's gravity and travel away from the planet made space exploration a reality.

Questions to guide explorations and experiments

- How can humans observe and explore space?
- What is gravity? How do we experience gravity on Earth? Is there gravity in space?
- How does a rocket get into space?
- What else revolves around the Sun?
- What kinds of challenges and work are involved in getting people into space?

Books and activities

- **Books:** fiction, nonfiction and poetry all about telescopes, gravity, rockets, astronauts, and exploring space
- **Activities:** explore and make tools for observing and getting to space; discover the challenges of becoming and being an astronaut

Children's Books

Fiction

- *CatStronauts: Space Station Situation* by Drew Brockington (Ages 6-9)
- *Commander Toad* series by Jane Yolen (Ages 6-9)
- *El Mundo de Copocuqu: La Reina Gravedad y el Rey Masa (The World of Copocuqu: Queen Gravity and King Mass)* by Adriana C. Ocampo Uria (Ages 6-9)
- *Just Right: Searching for the Goldilocks Planet* by Curtis Manley (Ages 6-9)
- *Maria's Comet* by Deborah Hopkinson (Ages 6-9)
- *Max Goes to Jupiter: A Science Adventure with Max the Dog* by Jeffrey Bennett (Ages 6-9)
- *Max Goes to the Space Station* by Jeffrey Bennett (Ages 6-9)
- *Mousetronaut* by Mark Kelly (Ages 4-8)
- *Tiny Little Rocket* by Richard Collingridge (Ages 4-8)

Poetry

- *Galileo's Universe* by J. Patrick Lewis (Ages 9-12)
- *Out of This World: Poems and Facts About Space* by Amy Sklansky (Ages 6-9)

Biography

- *Almost Astronauts: 13 Women Who Dared to Dream* by Tanya Lee Stone (Ages 9-12)
- *Chasing Space* by Leland Melvin (Ages 9-12)
- *Counting on Katherine: How Catherine Johnson Saved Apollo 13* by Helaine Becker (Ages 6-9)
- *Mae Among the Stars* by Roda Ahmed (Ages 4-8)
- *Path to the Stars: My Journey from Girl Scout to Rocket Scientist* by Sylvia Acevedo (Ages 9-12)
- *To Space and Back* by Sally Ride (Ages 9-12)
- *Starry Messenger: Galileo Galilei* by Peter Sis (Ages 6-9)
- *What Miss Mitchell Saw* by Hayley Barrett (Ages 4-8)
- *Who Was Neil Armstrong?* by Roberta Edwards (Ages 9-12)

Children's Books

Nonfiction

- *Astronaut Academy* by Steve Martin (Ages 6-9)
- *Astronaut Handbook* by Meghan McCarthy (Ages 6-9)
- *Astronaut in Training* by Catherine Ard (Ages 6-9)
- *To Burp or Not to Burp: A Guide to Your Body in Space* by Dave Williams (Ages 6-9)
- *Exploring Space: From Galileo to the Mars Rover and Beyond* by Martin Jenkins (Ages 9-12)
- *Floating Home* by David Getz (Ages 6-9)
- *Floating in Space* by Franklyn Branley (Ages 4-8)
- *Gravity* by Jason Chin (Ages 9-12)
- *Gravity Is a Mystery* by Franklyn Branley (Ages 4-8)
- *How to Be a Space Explorer* by Lonely Planet (Ages 9-12)
- *I Fall Down* by Vicki Cobb (Ages 4-8)
- *I Want to Be an Astronaut* by Byron Barton (Ages 4-8)
- *The International Space Station* by Franklyn Branley (Ages 4-8)
- *Mighty Mission Machines: From Rockets to Rovers* by Dr. Dave Williams and Loredana Cunti (Ages 9-12)
- *Professor Astro Cat's Space Rockets* by Dominic Walliman (Ages 6-9)
- *Science Comics: Rockets: Defying Gravity* by Anne Drozd (Ages 9-12)
- *Rockets and Spaceships* (DK Readers) by Dr. Karen Wallace (Ages 6-9)
- *Rocketry: Investigate the Science and Technology of Rockets and Ballistics* by Carla Mooney (Ages 9-12)
- *Space Exploration* by Dan Green and Simon Basher (Ages 9-12)
- *Spacewalk: The Astounding Gemini 4 Mission* by Carl R. Green(Ages 9-12)
- *Star Spotters: Telescopes and Observatories* by David Jefferis (Ages 9-12)

Space Words

Accelerate
To increase the speed or rate of something.

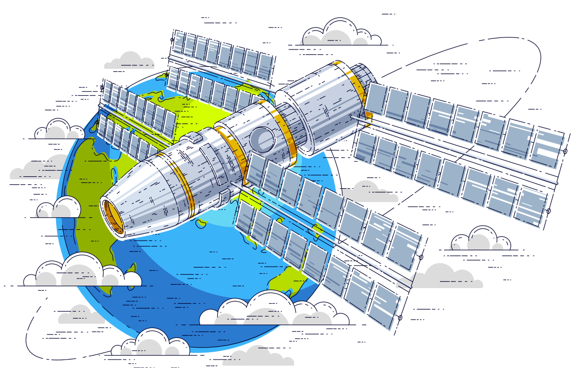
Astronomer / Astronomy
A scientist who studies space and the Universe beyond Earth. Astronomy is the branch of science that studies space.

Eyepiece
The lens closer to your eye in a telescope, through which you view objects in the sky.

Force
Power, energy, or physical strength. The strength or power applied to an object.

Gravity
A force that pulls matter together; a force that pulls people and objects toward the ground.

International Space Station
A large spacecraft in low orbit around Earth. It serves as a home and science laboratory for crews of astronauts from around the world. It orbits Earth every 90 minutes.



Lens
A piece of clear material such as glass that bends light rays passing through it. The surface of a lens is curved to bend light rays toward or away from a central point.

Magnify
To make something appear larger.

Mission
An important task that one is sent out to do. A space mission is a journey into space (unmanned or with a crew) for a specific reason — usually to gather scientific information.

Objective lens
The lens that gathers light from the object being looked at and focuses the light rays to produce an image.

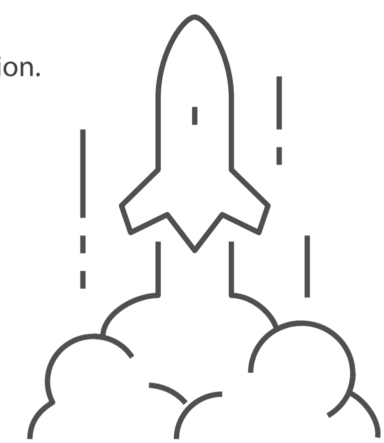
Refract
To bend as you move from one medium to another. Example: The movement of air and dust in the atmosphere bends, or *refracts,* a star's light in different directions.

Rocket
A flying device, shaped like a tube, that is pushed by hot gases released from engines in its rear. Rockets are used to launch spacecraft.

Telescope
An instrument that uses lenses and mirrors to make far away objects look larger and closer to us.

Thrust
To push or drive something with force.

Velocity
The rate of speed or motion.



Activity 1: DIY Telescopes

Introduction

Telescopes take our eyes beyond Earth to the stars and planets of the night sky. The curves of a telescope's glass or plastic lenses make this possible. The curved surface bends light — or **refracts** it — and the light changes direction. This change in direction makes objects seen through the telescope's lenses seem bigger than they really are.

The refracting telescope uses **lenses** to bring more light rays to a focus in your eye. Kids can make a simple refracting telescope with a tube that contains two lenses: one at the front end which gathers light, called the **objective lens**; and another that is closest to the user's eye, called the **eyepiece.** The objective lens collects the light. The eyepiece lens takes the collected light and **magnifies** what you are looking at.

Supplies (for each telescope)

- A pair of weak reading glasses — the kind you can get from the drugstore
- A small, strong magnifying glass
- Heavy cardstock or cardboard tubes, about 10-12 inches long, with a diameter slightly larger than your magnifying glass lens
- Masking tape
- Scissors

If kids working will be working in small groups, be sure to have enough of items 1-3 for each group.

Get kids thinking

To observe objects in space, you need to get a closer look! **Ask kids:** Why can't you see things that are very far away? What can you do to observe things that are far, far away? What kinds of tools or technology do you know about that can help you take a closer look at objects that are very distant?

Kick off discussion with older kids with this TED-Ed video: *The Story Behind Your Glasses* https://ed.ted.com/lessons/the-story-behind-your-glasses-eva-timothy

Activity 1: DIY Telescopes

Let's get started!

Have kids look at the supplies you've provided for making a refracting telescope. Explain what the lenses are. Talk about how a telescope works and discuss what kinds of information telescopes provide about the solar system and beyond.

Let kids play a role in engineering their telescope. Explain that the tube that holds the lenses is really two tubes — one that fits inside the other — that need to have openings that can hold the lenses. **Ask kids:** Will the lenses fit into the bottom of the cardboard tube? How can they make them fit?

Experiment together to either narrow a tube by cutting along its length, making the tube smaller as it is fitted around the lens and then taped into shape, or to create a larger tube by rolling cardstock to the diameter of the lens and taping it into shape.

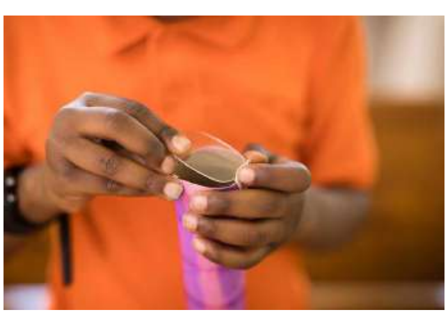
Warning: Never, under any circumstances, should kids point their telescope at the sun. The ultraviolet (UV) rays from the sun will permanently damage their eyes.

Once everyone understands how to make tubes and safe use of the telescopes, provide these instructions for making the telescope:

1. Form a tube for the stronger lens (your magnifying glass). The lens should be at the bottom of the tube and with the edges of the lens taped neatly to the tube to keep it secure. This is the telescope's eyepiece.

2. Form a tube for the objective lens that is either bigger or smaller in diameter than your first tube. Tape the lens neatly to the end of the tube.

3. Insert the empty end of one tube into the empty end of the other tube. Look through the eyepiece and point the other end of the telescope at a distant object. Slide the two tubes in and out until the object comes into focus. If it is difficult to focus the telescope, experiment with lengthening the tube.



Photos © National Geographic Kids

Activity 1: DIY Telescopes

Ask kids: What do you see? Are you surprised to find things upside down?

To help kids think more about why images appear upside down, have them look at their reflection in a spoon and talk about the similarities between the curve of the spoon and the way light is curved through the lens of their telescope.

Do kids have ideas for how they could make their telescope more effective or powerful? Not show upside-down images?

Photo © National Geographic Kids

More telescope and astronomy activities

Make Your Own Hand-Held Hubble
http://hubblesite.org/the_telescope/hand-held_hubble/

Observing with NASA
https://mo-www.cfa.harvard.edu/OWN/index.html

Activity 2: Exploring Gravity

Introduction

Gravity is an invisible force that pulls objects toward each other. On Earth, gravity continuously pulls us and everything on Earth (and in Earth's orbit) down towards the ground. The closer an object is to Earth, the more its gravity pulls on it. To explore space, spacecrafts have to overcome Earth's gravity, have kids build a model rocket to explore the **force** and **thrust** needed to launch a real rocket into space.

Supplies

- Straight, jumbo size (smoothie) straws
- Flexible drinking straws, standard size (standard straws need to slide inside the jumbo straws easily without too much extra space)
- 2 adhesive labels, 1" x 2.5" (for each rocket)
- Modeling clay (small ball to fill the end of the smoothie straw)
- Scissors
- Small stuffed animal (optional)
- Masking tape
- Tape measure

You'll need some space for launching the rockets!

Get kids thinking

Check kids understanding of gravity. Do they think things just naturally fall? They should understand that objects and people "fall" towards Earth because of gravity.

Watch this Crash Course Kids video: Defining Gravity (https://youtu.be/ljRlB6TuMOU) or try a demonstration:

Activity 2: Exploring Gravity

Hold up a small stuffed animal. Drop it on the floor and **ask kids**: What happened? Talk about how the force of gravity continuously pulls things down towards the ground. Next, toss the stuffed animal up into the air and then let it fall to the ground and **ask kids** how the toy fell to the ground this time. Talk about the force you used to toss the stuffed animal up and the force of gravity that pulled it down to the ground.

Let's get started!

Have kids jump straight up as high as they can. **Ask kids:** how do you feel? How much energy did you use to jump? Were you able to jump very high? How does a rocket get so high? Why can't you jump as high?

Talk about the incredible amount of energy it takes to launch a rocket to overcome Earth's gravity. In a rocket engine, when ignited rocket fuel heats up, rapidly expanding gases are forced out of the tail of the rocket. This generates the upward **thrust** which pushes the rocket into the air.

In this activity, kids use moving air blown through a straw to provide the thrust.

Provide kids with a jumbo straw, small clay ball, and labels. Have kids use the clay to stop up one end of the straw. This is the nose of the rocket. Have them fashion a nose cone by cutting one of the labels in half and wrapping it around the top of the straw, covering the clay.

Kids should cut the remaining label in half. They should use those halves along with the half label left over from the nose cone to make fins. Fins are at the opposite end of the rocket's nose. Kids should attach one end of the label to the straw, fold and crease the piece in half, and attach the remaining bit of label to the straw. The should position 3 fins around the base of the straw. (See photo at right).

Photo © Breece Walker

Activity 2: Exploring Gravity

Now kids are ready to launch! Have them bend the neck of the flexible drinking straw to a right angle. Next, they should slide the long end of the straw into the base of the rocket. Before anyone blows into the short end of the drinking straw to launch, make sure everyone has plenty of room and that no one is in the way of an incoming rocket.

Count down 10-9-8-7-6-5-4-3-2-1, blast off!

Photo © Breece Walker

After this initial test flight, measure out a flight zone with masking tape so kids can see how far their rockets travel in future flights. Have them launch again. Encourage kids to make observations about their rocket launch. Ask kids: Where did it go? How high? How far down the flight zone? What could you change about your rocket or your launch to make it go higher or travel farther? Talk about how the clay prevents the air from escaping from the rocket and is pressurized, producing a force — thrust.

Give kids a chance to modify their rockets, try different launch angles, blow harder, or redesign something different to test. Let them keep launching and revising and then discuss how their ideas and changes worked or didn't work.

Activity 2: Exploring Gravity

Launch	Launch Angle	Air Output	Distance	Observations
1				
2				
3				
4				
5				

More rocket activities

Simple Rocket Science
https://www.jpl.nasa.gov/edu/teach/activity/simple-rocket-science/

Up, Up, Up! Build and Launch Your Own Rockets
https://www.esa.int/Education/Teachers_Corner/Up_up_up!_Build_and_launch_your_own_rockets_Teach_with_space_PR23

Activity 3: Moving and Working in Space

Introduction

Getting ready to live and work in space takes a lot of preparation. It can take up to two years of training to become an astronaut and get assigned to a **mission**. Astronauts face challenges from how to deal with weightlessness to dangers from space debris and malfunctioning technology when they travel and live in space (at the **International Space Station**). In these activities, kids learn about the space environment and some of the physical challenges faced by astronauts.

Supplies

- Timer
- Work gloves (2 pairs)
- Winter gloves (2 pairs)
- 4 carabiners or binder clips
- 50 feet of thin rope or heavy string
- 2 empty plastic jars with screw-on lids, such as a peanut butter jar
- LEGO® bricks (10 bricks in a container with a lid)
- 4 chairs
- Stopwatch

This allows two "astronauts" to go on a spacewalk at one time.

Get kids thinking

Ask kids: If you are an astronaut who lives and works in space, where do you sleep? And eat? And work?

Share a quick overview of What It's Like to Live on the International Space Station with kids: https://www.businessinsider.com/what-its-like-to-live-on-the-international-space-station-2015-9

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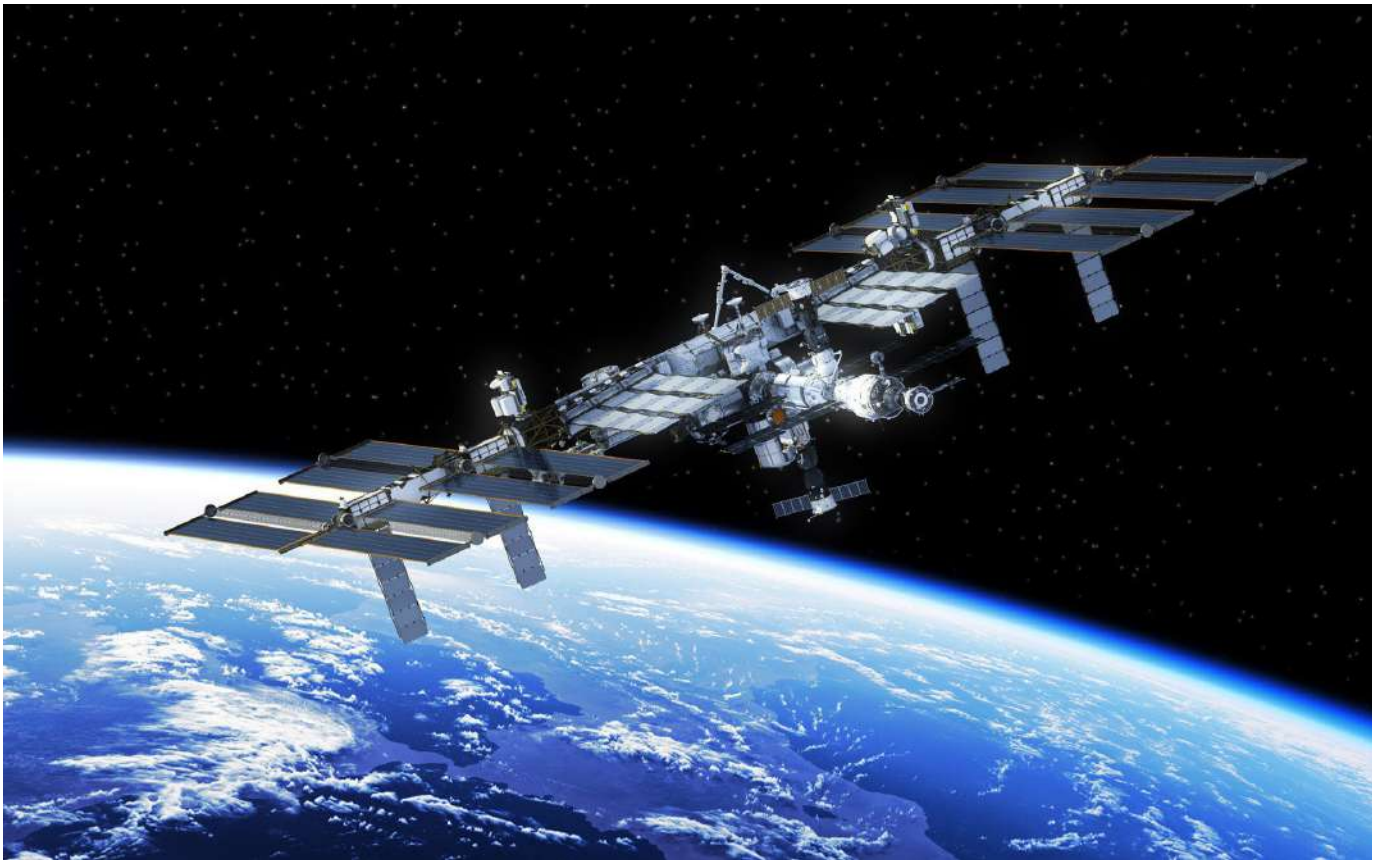
The International Space Station



The International Space Station. Photo © NASA

Activity 3: Moving and Working in Space

Or follow astronauts on the International Space Station in a series of videos as they explain their daily routines: https://www.nasa.gov/audience/foreducators/stem-on-station/dayinthelife

To get to live and work on the space station, astronauts train to improve their overall physical fitness. **Ask kids:** Why is that important? What kinds of work do astronauts do that require good strength and balance? How does living in space affect an astronaut's body? How would you get prepared to go to space?

Let's get started!

When exploring space, astronauts complete many physical tasks and must be able to twist, bend, lift, and carry massive objects to do their work. Even "walking" takes different physical effort in the reduced gravity environment of space, with astronauts pushing and pulling themselves from one place to another.

Flight Engineer Karen Nyberg exercising in the International Space Station. Photo © NASA

And being physically fit and continuing regular exercise (2 hours a day on the International Space Station!) is the most effective way to counteract the effects of weightlessness on the human body to maintain muscle strength and good bone health.

Lead kids through this **Astronaut Workout** and get them talking about how these exercises would benefit them when training to work and live in space.

Astronaut workout

Stretch
In the reduced gravity environment of space, NASA has found that the height of astronauts increases approximately 3% over the first 3 to 4 days in space. Everybody's body stretches in space! Stretch with your arms high above your head and hold for 30 seconds. Repeat 4 times.

Activity 3: Moving and Working in Space

Balance

How long can you balance on one leg? Try to balance on your right leg for 60 seconds. Now try to balance on your left leg for 60 seconds. Try each leg again, this time with eyes closed.

Extra challenge: Pass a ball back and forth with a friend while balancing on one leg.

Float

Get used to the position of floating in space. Lie on your stomach and stretch your arms out like an airplane. Hold for 30 seconds. Relax, then repeat 4 times.

Extra challenge: Raise your chest up and move your arms like you are swimming using the breaststroke.

Bear Crawl

Get down on your hands and feet (facing the floor) and walk on all fours like a bear, without your knees touching the ground. Try to go 20 feet [to where I am standing]. Rest for a minute. Bear crawl back to where you started. Repeat.

Crab Walk

Sit on the ground and put your arms and hands behind you, with you knees bent and feet on the floor. Lift yourself off the ground (facing upwards). Try to go 20 feet [to where I am standing]. Rest for a minute. Crab walk back to where you started. Repeat.

Jump

Jump as high off the floor as you can, and land lightly. Keep jumping for 30 seconds.

Extra challenge: Start your jump in a squat position and return to squat when you land. Jump for 30 seconds.

Breathe

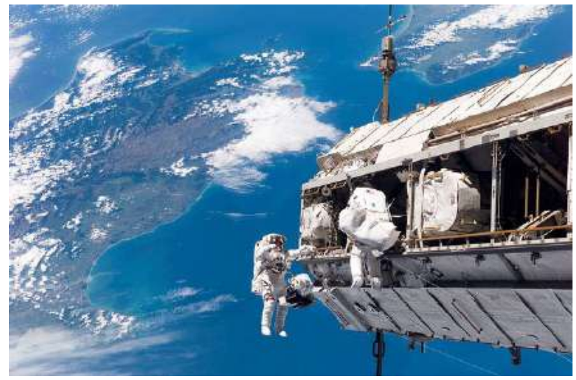
Life in space can be stressful. Breathing exercises can relax you. Take a deep breath in as you raise your arms over your head. Let the breath out as you drop your arms down. Repeat for one minute or more.

Activity 3: Moving and Working in Space

Work in space

Now that everyone is warmed up, have kids put balance and agility to use as they see what it might be like to have to repair something on the outside of a spacecraft.

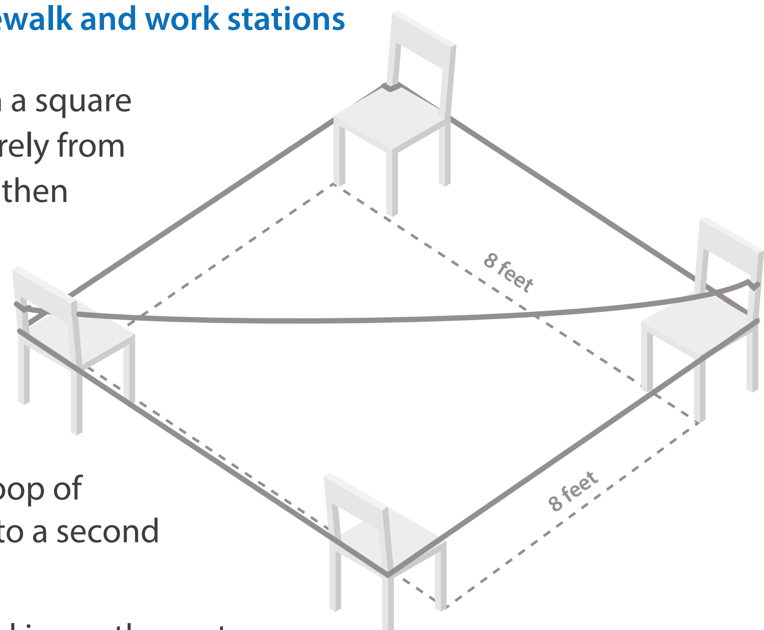
Ask kids: Have you ever had to wear something that made it hard to move around? Like lots of layers of clothes or a costume? Something that was too big or too small?



Spacewalk outside the International Space Station. Photo © NASA

Talk about the challenges for an astronaut having to work in a space suit to complete tasks while out in space. You may want to have kids explore NASA's Interactive Spacesuit Experience: www.nasa.gov/audience/foreducators/spacesuits/home/clickable_suit.html

While they explore, you can set up the spacewalk and work stations



- To create the spacewalk area, set 4 chairs in a square about 8 feet apart. Tie lengths of rope securely from one chair to the next to form a square, and then cross the rope diagonally across the middle of the square and secure to the chairs to create slide wires for astronaut tethers. There should be some slack.
- To prepare a tether, cut 2 feet of rope and tie one end to a carabiner or to the metal loop of a binder clip. Tie the other end of the rope to a second carabiner or binder clip.
- On one chair, set an opened jar and a closed jar on the seat.
- At the opposite chair, set the box of LEGO bricks.
- On a remaining empty chair, place sets of gloves.

Activity 3: Moving and Working in Space

Get your astronauts ready to go! **Ask kids:** Why do astronauts go on spacewalks? How do they stay safe during spacewalks?

Talk about how spacewalks let astronauts work, do science, test new equipment or repair satellites or spacecraft that are in space. Explain that the spacewalk today includes:

- Opening one "vent" (opening a closed jar) and closing another "vent" (closing an open jar)
- Increasing the length of a robotic arm (connecting 5 LEGO® bricks)

As part of their spacewalk, kids must remain attached to their tether and slide wire. In order to get to both work stations, they must slide their carabiners/clips to an adjacent rope and then attach themselves to that rope.

And to protect against the hostile environment of space, kids need to wear gloves. Astronaut gloves have multiple layers, so kids should put on 2 pairs of gloves.

Two astronauts can spacewalk at a time, but for safety reasons, should not pass each other. Have kids look for a different route.

Astronauts can spacewalk for many, many hours. But this spacewalk is a race against the clock. See how quickly all your astronauts can complete the tasks.

After the spacewalk, **ask kids:** What was the spacewalk experience like? What things were challenging about it? How did the tethers work? Are there other ways to keep astronauts in place?

[Adapted from the Canadian Space Agency's activity "Moving and Working in Space"]
http://www.asc-csa.gc.ca/eng/educators/resources/working.asp

More astronaut training activities

Train Like an Astronaut: Adapted Physical Activity Strategies
https://www.nasa.gov/sites/default/files/ape_all_as_one_tla.pdf

Train like an astronaut
https://www.stem.org.uk/missionx/resources

Writing About Space Exploration

Writing helps kids process and solidify new knowledge and gives them an opportunity to use new vocabulary and concepts. Offer one or more of these prompts or questions to get your Space Rangers writing.

Writing prompts

- Imagine you are a journalist getting ready to interview an astronaut. Write your questions. Then, imagine you are an astronaut. Research and write answers to your questions!
- Write an essay about how a telescope can be like a time machine.
- Choose an astronaut you admire or want to learn more about. Write and illustrate a picture book biography which shares the childhood experiences, struggles, and accomplishments of your astronaut.
- Write a story about how our lives on Earth would be different if the rocket had never been invented.
- Think about how gravity affects your everyday life. Write a story about how life on Earth would be different if there was much less gravity.
- Write a letter to a friend explaining why you think they should or should not become an astronaut.

Story Time from Space

Story Time from Space features videos of astronauts reading books aloud from the International Space Station. Watch a story at: https://storytimefromspace.com/. Write a review of the book and of the reader's performance.

Writing About Space Exploration

Be a cosmic poet

Write poetry about the tools and technologies we've used to make discoveries about the universe: https://www.jpl.nasa.gov/edu/teach/activity/planetary-poetry/

Mission to ...

Invent a space-themed board game that puts players through the challenges of astronaut training, mission planning, and traveling to the space station (or the Moon or Mars). First astronaut back on Earth wins! Don't forget to write down the directions for how to play!

Kid-friendly Websites and Apps

Websites

Telescopes from the Ground Up (Amazing Space)
http://history.amazingspace.org/resources/explorations/groundup/

Galileo history lesson, or why you shouldn't smart off to those in charge
https://adventuresinmommydom.org/galileo-unit-study/

Video: Gravity Compilation (Crash Course Kids)
https://youtu.be/EwY6p-r_hyU

Gravity in Orbit (Smithsonian National Air and Space Museum)
http://howthingsfly.si.edu/flight-dynamics/gravity-orbit

Rocket Lab (Smithsonian National Air and Space Museum)
http://howthingsfly.si.edu/activities/rocket-lab

Video: How Do You Get a Rocket to Land Back on Earth? (NOVA)
https://www.pbs.org/wgbh/nova/video/how-do-you-get-a-rocket-to-land-back-on-earth/

Space Exploration Timeline (Sea and Sky)
http://www.seasky.org/space-exploration/space-timeline-menu.html

Living and Working in Space (PBS Learning Media)
https://www.pbslearningmedia.org/collection/living-and-working-in-space/

NASA Kids' Club
https://www.nasa.gov/kidsclub/index.html

Kid-friendly Websites and Apps

Educational apps

Gravity Launch (Apple and Android)
http://sciencenetlinks.com/gravity-launch/

NASA (Apple)
https://www.commonsensemedia.org/app-reviews/nasa

Globe Oberver (Apple and Android)
An international citizen science initiative to understand our global environment. Start submitting cloud observations today!
https://observer.globe.gov/about/get-the-app

This is my Spacecraft – Rocket Science for Kids (Apple) $
https://www.commonsensemedia.org/app-reviews/this-is-my-spacecraft-rocket-science-for-kids

Simple Rockets (Apple and Android) $
https://www.commonsensemedia.org/app-reviews/simplerockets

SMART Adventures Mission Math 1: Sabotage at the Space Station (Apple and Android) $
https://www.commonsensemedia.org/app-reviews/smart-adventures-mission-math-1-sabotage-at-the-space-station

NASA: Space Science Investigations: Plant Growth (Apple and Android)
https://www.commonsensemedia.org/app-reviews/space-science-investigations-plant-growth

Appendix

Space Exploration Timeline

Inventions from Space Exploration

Books About Space

Space Words

Printables
(Name tags, journal covers, certificates,
Growing Readers tip sheets)

Space Exploration Timeline

Humans have been interested in space for centuries. Here are highlights fom nearly 500 years of curiosity, innovation, and exploration. (Edited from a timeline by *Astronomy for Kids*.)

1543 Nicolaus Copernicus published *On the Revolutions of the Heavenly Spheres* claiming that the Earth and the planets orbited the Sun.

1609 Galileo first used the telescope to view the stars and planets.

1668 Isaac Newton invented the first reflecting telescope.

1686 Isaac Newton published the *Mathematical Principles of Natural Philosophy* where he described his theory of gravity and the motion of the Sun and the planets.

1801 The first asteroid, Ceres, is discovered by Giuseppe Piazzi.

1926 Robert Goddard invented and launched the first liquid-fueled rocket. Goddard's work on rocket technology would make spaceflight possible.

1942 The German V-2 rocket became the first vehicle to enter outer space. The rocket was designed by Wernher Von Braun, who later worked with NASA as the creator of the rockets that went to the moon.

1947 Fruit flies became the first animals to go to outer space aboard a V-2 rocket sent by the United States, to study the effects of space travel on animals.

The Space Age Begins!

1957 Russia (USSR) launched Sputnik 1 which became the first satellite into orbit around Earth. This started Space Race between the Russians and the United States. Today there are more than 500 working satellites in space. Sputnik means "Satellite" in Russian.

1957 The Russian dog Laika ("barker" in Russian) became the first animal in orbit.

1959 First creatures to return alive from space (two monkeys).

1961 Russian cosmonaut Yuri Gagarin became the first human in space and the first human to orbit the Earth.

Space Exploration Timeline

1961 Alan Shepherd became the first American in space just three weeks after Yuri Gagarin. President Kennedy declares the American space objective to put a man on the moon and return him safely by the end of the decade.

1962 John Glenn became the first American to orbit the Earth.

1963 Russian Cosmonaut Valentina Tereshkova became the first woman in space.

1965 Russian cosmonaut Alexei Leonov was the first man to walk in space.

1969 The Apollo 11 spacecraft landed on the Moon and Neil Armstrong became the first man to walk on the Moon. Armstrong and Edwin "Buzz" Aldrin spent two hours on the lunar surface setting up observation equipment and collecting rock samples.

1970 On the third manned mission to the Moon, Apollo 13 suffered an explosion caused by a wiring fault. Using only whatever was on board, NASA scientists and the astronauts on board improvised repairs to bring the crippled spaceship home.

1971 The USSR launched the first space station called Salyut 1.

1973 The United States launched its first space station called Skylab.

1976 Viking 1 successfully landed on Mars. It sent back pictures and scientific data for the next six years.

1981 The United States launched the first Space Shuttle, Columbia. The program eventually launched 135 space missions over the next thirty years.

1983 Sally Ride became the first American woman in space.

1986 Tragedy struck. Space Shuttle Challenger exploded shortly after launch, because of a fuel system failure. All seven astronauts on board were killed, and all shuttles were grounded for nearly three years.

1990 The Hubble Space Telescope was carried into orbit by a Space Shuttle. The Hubble Space Telescope is acclaimed as one of the most significant astronomical instruments in history. It is still in orbit after servicing by Space Shuttle astronauts.

1997 First operational rover landed on another planet (Mars).

1998 The International Space Station (ISS) was launched into space.

Space Exploration Timeline

2001	American millionaire Dennis Tito became the first space tourist when he paid around 20 million dollars for a ride in a Russian Soyuz spacecraft. He spent a week in orbit, most of the time visiting the International Space Station. He had to train for 900 hours just to be a passenger!
2004	The Cassini spacecraft sent back photographs of Saturn's shimmering rings.
2004	"Spirit" rover landed on Mars.
2008	As NASA began to plan retirement for the Space Shuttle, private companies began work on spacecraft to replace it. One of these companies, SpaceX, became the first to launch a privately funded liquid-fueled rocket into Orbit, the Falcon 1. SpaceX now uses its Falcon rockets to launch their Dragon capsule — an unmanned vehicle that takes supplies to the ISS.
2011	Final space shuttle mission ends when Atlantis arrives at Kennedy Space Center.
2015	First food grown in space eaten (lettuce).
2019	A Chinese lander made the first successful soft landing on the far side of the Moon.

Inventions from Space Exploration

NASA research has led to these innovations:

- Satellite GPS
- Camera phones
- Scratch-resistant glasses
- Better firefighter gear
- Roadway safety grooves
- LEDs for growing plants and healing people
- CAT scans
- Artificial limbs
- Invisible braces
- Ear thermometers
- Better radial tires
- Memory foam
- Baby formula nutrients (from algae!)
- Freeze dried food
- Solar power cells
- Oil spill clean up technology
- Water purification systems
- Home insulation
- Wireless headsets
- The computer mouse!
- Portable computers

Books About Space

Fiction

- *A Big Mooncake for Little Star* by Grace Lin (Ages 4-7)
- *Blackout* by John Rocco (Ages 6-9)
- *The Boy Who Went to Mars* by Simon James (Ages 4-8)
- *Bright Sky, Starry City* by Uma Krishnaswami (Ages 6-9)
- *CatStronauts: Space Station Situation* by Drew Brockington (Ages 6-9)
- *City Moon* by Rachael Cole (Ages 4-8)
- *Commander Toad* series by Jane Yolen (Ages 6-9)
- *The Countdown Conspiracy* by Katie Slivensky (Ages 9-12)
- *Coyote Places the Stars* by Harriet Peck-Taylor (Ages 4-8)
- *El Mundo de Copocuqu: La Reina Gravedad y el Rey Masa (The World of Copocuqu: Queen Gravity and King Mass)* by Adriana C. Ocampo Uria (Ages 6-9)
- *Her Seven Brothers* by Paul Goble (Ages 6-9)
- *How the Stars Fell into the Sky* by Jerrie Oughton 6-9)
- *I Love You, Michael Collins* by Lauren Baratz-Logsted (Ages 9-12)
- *Imani's Moon* by JaNay Brown-Wood (Ages 6-9)
- *Just Right: Searching for the Goldilocks Planet* by Curtis Manley (Ages 6-9)
- *Life on Mars* by Jon Agee (Ages 4-8)
- *The Lizard and the Sun / La Lagartija y el Sol* by Alma Flor Ada (Ages 4-8)
- *Luciana: Out of This World* by Erin Teagan (Ages 9-12)
- *The Man in the Moon* by William Joyce (Ages 6-9)
- *Maria's Comet* by Deborah Hopkinson (Ages 6-9)
- *Max Goes to Jupiter: A Science Adventure with Max the Dog* by Jeffrey Bennett (Ages 6-9)
- *Max Goes to the Space Station* by Jeffrey Bennett (Ages 6-9)
- *Max Goes to Mars* by Jeffrey Bennett (Ages 6-9)
- *Miss Tracy Is Spacey!* by Dan Gutman (Ages 6-9)
- *A Moon of My Own* by Jennifer Rustigi (Ages 6-9)
- *The Moon Over Star* by Dianna Hutts Aston (Ages 6-9)

Books About Space

Fiction

- *Mousetronaut* by Mark Kelly (Ages 4-8)
- *Mousetronaut Goes to Mars* by Mark Kelly (Ages 4-8)
- *Mr. Wuffles* by David Wiesner (Ages 4-8)
- *Music for Mister Moon* by Philip C. Stead (Ages 4-8)
- *Owl Moon* by Jane Yolen (Ages 4-8)
- *The Story of the Milky Way* by Joseph Bruchac (Ages 6-9)
- *Pluto Is Peeved: An Ex-Planet Searches for Answers* by Jacqueline Jules (Ages 6-9)
- *Starry River of the Sky* by Grace Lin (Ages 9-12)
- *Stink: Solar System Superhero* by Megan McDonald (Ages 4-8)
- *Thanking the Moon* by Grace Lin (Ages 4-8)
- *There Was an Old Martian Who Swallowed the Moon* by Jennifer Ward (Ages 4-8)
- *Tiny Little Rocket* by Richard Collingridge (Ages 4-8)
- *The Truth About Martians* by Melissa Savage (Ages 9-12)
- *The Way Back Home* by Oliver Jeffers (Ages 4-8)
- *Where the Mountain Meets the Moon* by Grace Lin (Ages 9-12)
- *Zathura* by Chris Van Allsburg (Ages 4-8)

Poetry

- *Comets, Stars, the Moon, and Mars: Space Poems and Paintings* by Douglas Florian (Ages 6-9)
- *The Day the Universe Exploded My Head* by Allan Wolf (Ages 9-12)
- *Eight Days Gone* by Linda McReynolds (Ages 4-8)
- *Faces of the Moon* by Bob Crelin (Ages 6-9)
- *A Full Moon Is Rising* by Marilyn Singer (Ages 6-9)
- *Galileo's Universe* by J. Patrick Lewis (Ages 9-12)
- *Once Upon a Star: A Poetic Journey Through Space* by James Carter (Ages 6-9)
- *Out of This World: Poems and Facts About Space* by Amy Sklansky (Ages 6-9)
- *Stuff of Stars* by Marion Bauer (Ages 6-9)
- *Thirteen Moons on Turtle's Back: A Native American Year of Moons* by Joseph Bruchac (Ages 4-8)
- *When the Moon Is Full: A Lunar Year* by Mary Azarian (Ages 6-9)

Books About Space

Biography

- *Almost Astronauts: 13 Women Who Dared to Dream* by Tanya Lee Stone (Ages 9-12)
- *A Computer Called Katherine: How Katherine Johnson Helped Put America on the Moon* by Suzanne Slade (Ages 6-9)
- *Caroline's Comets: A True Story* by Emily Arnold McCully (Ages 6-9)
- *Chasing Space* by Leland Melvin (Ages 9-12)
- *Counting on Katherine: How Catherine Johnson Saved Apollo 13* by Helaine Becker (Ages 6-9)
- *Galileo's Universe* by J. Patrick Lewis (Ages 9-12)
- *Hidden Figures* by Margot Lee Shetterley (Ages 6-9)
- *I, Galileo* by Bonnie Christensen (Ages 6-9)
- *The Librarian Who Measured the Earth* by Kathryn Lasky (Ages 9-12)
- *Look Up! Henrietta Leavitt, Pioneering Woman Astronomer* by Robert Burleigh (Ages 6-9)
- *Mae Among the Stars* by Roda Ahmed (Ages 4-8)
- *Margaret and the Moon: How Margaret Hamilton Saved the First Lunar Landing* by Dean Robbins (Ages 4-8)
- *Nicolaus Copernicus: The Earth Is a Planet* by Dennis Fradin (Ages 9-12)
- *Path to the Stars: My Journey from Girl Scout to Rocket Scientist* by Sylvia Acevedo (Ages 9-12)
- *The Planet Hunter: The Story Behind What Happened to Pluto* by Elizabeth Rusch (Ages 4-8)
- *To Space and Back* by Sally Ride (Ages 9-12)
- *Starry Messenger: Galileo Galilei* by Peter Sis (Ages 6-9)
- *What Miss Mitchell Saw* by Hayley Barrett (Ages 4-8)
- *Who Was Neil Armstrong?* by Roberta Edwards (Ages 9-12)

Books About Space

Nonfiction

- *Apollo 13 (Totally True Adventures)* by Kathleen Weidner Zoehfeld (Ages 6-9)
- *Astronaut Academy* by Steve Martin (Ages 6-9)
- *Astronaut Handbook* by Meghan McCarthy (Ages 6-9)
- *Astronaut in Training* by Catherine Ard (Ages 6-9)
- *To Burp or Not to Burp: A Guide to Your Body in Space* by Dave Williams (Ages 6-9)
- *Comets, Meteors, and Asteroids: Voyagers of the Solar System* by Ellen Lawrence (Ages 6-9)
- *Countdown: 2979 Days to the Moon* by Suzanne Slade (Ages 9-12)
- *Curiosity: The Story of the Mars Rover* by Markus Motum (Ages 9-12)
- *Destination Mars* by Seymour Simon (Ages 6-9)
- *Exploring Our Solar System* by Sally Ride and Tam O'Shaughnessy (Ages 9-12)
- *Exploring Space: From Galileo to the Mars Rover and Beyond* by Martin Jenkins (Ages 9-12)
- *Floating Home* by David Getz (Ages 6-9)
- *Floating in Space* by Franklyn Branley (Ages 4-8)
- *Footprints on the Moon* by Alexandra Siy (Ages 6-9)
- *Go for the Moon: A Rocket, a Boy, and the First Moon Landing* by Chris Gall (Ages 6-9)
- *Gravity* by Jason Chin (Ages 9-12)
- *Gravity Is a Mystery* by Franklyn Branley (Ages 4-8)
- *How to Be a Space Explorer* by Lonely Planet (Ages 9-12)
- *I Fall Down* by Vicki Cobb (Ages 4-8)
- *I Want to Be an Astronaut* by Byron Barton (Ages 4-8)
- *If You Decide to Go to the Moon* by Faith McNulty (Ages 4-8)
- *If You Had Your Birthday on the Moon* by Joyce Lapin (Ages 6-9)
- *The International Space Station* by Franklyn Branley (Ages 4-8)
- *Just Right: Searching for the Goldilocks Planet* by Curtis Manley (Ages 6-9)
- *Little Kids' First Big Book of Space* by National Geographic Kids (Ages 4-8)
- *Lost in Outer Space: The Incredible Journey of Apollo 13* by Tod Olson (Ages 9-12)
- *The Magic School Bus Lost in the Solar System* by Joanna Cole (Ages 6-9)
- *Magic School Bus Presents: Our Solar System* by Tom Jackson (Ages 6-9)
- *Mars: Our Future on the Red Planet* by Leonard David (Ages 9-12)
- *Me and My Place in Space* by Joan Sweeney (Ages 4-8)
- *The Mighty Mars Rovers* by Elizabeth Rusch (Ages 9-12)
- *Mighty Mission Machines* by Dr. Dave Williams and Loredana Cunti (Ages 9-12)

Books About Space

Nonfiction

- *Mission: Mars* by Pascal Lee (Ages 9-12)
- *Mission to Mars* by Franklyn Branley (Ages 4-8)
- *The Moon Book* by Gail Gibbons (Ages 6-9)
- *Moon! Earth's Best Friend (Our Universe)* by Stacy McAnulty (Ages 4-8)
- *The Moon Seems to Change* by Franklyn Branley (Ages 4-8)
- *Moonshot* by Brian Floca (Ages 6-9)
- *National Geographic Kids: Mars* by Elizabeth Carney (Ages 6-9)
- *One Giant Leap* by Robert Burleigh (Ages 6-9)
- *Our Solar System* by Seymour Simon (Ages 6-9)
- *The Planets* by Gail Gibbons (Ages 6-9)
- *The Planets in Our Solar System* by Franklyn Branley (Ages 4-8)
- *Professor Astro Cat's Solar System* by Dr. Dominic Walliman (Ages 6-9)
- *The Rocket that Flew to Mars* by Audrey Sauble (Ages 4-8)
- *Rockets and Spaceships* (DK Readers) by Dr. Karen Wallace (Ages 6-9)
- *Rocketry* by Carla Mooney (Ages 9-12)
- *Space Exploration* by Dan Green and Simon Basher (Ages 9-12)
- *Spacewalk: The Astounding Gemini 4 Mission* by Carl R. Green(Ages 9-12)
- *Star Spotters: Telescopes and Observatories* by David Jefferis (Ages 9-12)
- *Science Comics: Rockets: Defying Gravity* by Anne Drozd (Ages 9-12)
- *Science Comics: Solar System: Our Place in Space* by Rosemary Mosco (Ages 9-12)
- *Space: A Visual Encyclopedia* (DK Readers) (Ages 6-9)
- *The Sun Is Kind of a Big Deal* by Nick Seluk (Ages 4-8)
- *The Sun: Our Nearest Star* by Franklyn Branley (Ages 4-8)
- *Team Moon* by Catherine Thimmesh (Ages 9-12)
- *Welcome to Mars: Making a Home on the Red Planet* by Buzz Aldrin (Ages 9-12)
- *What Makes Day and Night?* by Franklyn Branley (Ages 4-8)
- *What the Moon Is Like* by Franklyn Branley (Ages 4-8)
- *What's Out There? A Book About Space* by Lynn Wilson (Ages 4-8)
- *You Are the First Kid on Mars* by Patrick O'Brien (Ages 6-9)
- *You Can't Ride a Bicycle on the Moon* by Harriet Ziefert (Ages 6-9)

Space Words

Accelerate
To increase the speed or rate of something.

Apollo 11
The historic mission where humans first walked on the Moon.

Asteroid
A rocky space object that can be a few feet wide to several hundred miles wide. Most asteroids in our solar system orbit in a belt between Mars and Jupiter.

Astronaut
A person trained to participate in space flights.

Astronomer / Astronomy
A scientist who studies space and the Universe beyond Earth. Astronomy is the branch of science that studies space.

Atmosphere
The layer of gases surrounding Earth and other planets, held in place by gravity.

Axis
An imaginary line that goes through a planet's center from top to bottom. A planet spins (rotates) around its own axis.

Big Dipper
Part of the constellation Ursa Major (Big Bear), made up of this constellation's seven brightest stars. These stars form a shape that looks like a ladle, or dipper.

Canyon
A deep valley with steep sides.

Comet
A frozen mass of gas and dust that orbits the Sun and may form a long, bright tail when it is flying close to the Sun.

Command Module (Columbia)
The Apollo 11 spacecraft that orbited the Moon while the Lunar Module was on the lunar surface. "Columbia" was piloted by astronaut Michael Collins.

Space Words

Constellation
A group of stars in the night sky forming patterns that look like animals, objects, or characters. There are 88 official constellations. At different times of the year and in different hemispheres, different constellations can be seen in the sky.

Crater
Large round holes in the ground. A bowl-shaped cavity caused by an asteroid impact.

Crescent Moon
The Moon as it appears early in its first quarter or late in its last quarter, when only a small arc-shaped section is lit up by the Sun.

Curiosity, Spirit, and Opportunity
Three car-sized Mars rovers designed to collect information about the Red Planet. Curiosity was launched November 26, 2011 and is still active.

Desert
A very dry, area with little or no rainfall to support plant life.

Dwarf planet
A non-satellite body that is in orbit around the Sun, has sufficient mass to have a nearly round shape, but is not the dominant body in its orbit.

Elliptical orbit
The oval (not round) pattern that describes how the planets in our solar system move around the Sun.

Eyepiece
The lens closer to your eye in a telescope, through which you view objects in the sky.

Erosion
The wearing away of a planet's surface by wind or water.

Exosphere
The outermost part of the atmosphere of a planet.

Far Side of the Moon
The side of the Moon that always faces *away* from Earth.

Space Words

Force
Power, energy, or physical strength. The strength or power applied to an object.

Full Moon
When Earth is located between the Sun and the Moon, the Moon appears fully lit up and appears like a bright, full circle.

Galaxy
A collection of billions of stars and other matter held together by gravity. Our planet Earth and the Sun belong to the Milky Way galaxy. A telescope helps us see other galaxies from Earth.

Gibbous Moon
The appearance of the Moon between a Half Moon and a Full Moon.

Gravity
A force that pulls matter together; a force that pulls people and objects toward the ground.

Half Moon
The phase when one-half of the Moon appears lit up.

Helium
A gas that is lighter than air. Balloons filled with helium will float high in the sky.

Hubble Telescope
A space telescope launched into low Earth orbit in 1990 and is still out there. The Hubble has taken thousands of images that have helped scientists and the public to understand our Universe better.

Hydrogen
A very light gas and one of the most abundant gases in the Universe.

Interstellar
The space located between stars.

International Space Station
A large spacecraft in low orbit around Earth. It serves as a home and science laboratory for crews of astronauts from around the world. It orbits Earth every 90 minutes.

Space Words

Iron Oxide
A substance formed when iron mixes with oxygen and water. Also called rust, it is red in color.

Lander
A type of spacecraft that is designed to land on the surface of a planet, comet, or moon, to retrieve or send scientific information.

Lens
A piece of clear material such as glass that bends light rays passing through it. The surface of a lens is curved to bend light rays toward or away from a central point.

Light year
The distance that light travels in one year, about 6 billion miles.

Little Dipper
The constellation Ursa Minor (Little Bear). The stars that make up this constellation also form a pattern that looks like a dipper.

Lunar
Having to do with the Moon, for example, the lunar landscape.

Lunar cycle
The Moon's continuous orbit around the Earth. It takes 27 days, 7 hours, and 43 minutes for our Moon to complete one full orbit around Earth.

Lunar eclipse
When the Moon's reflected light is hidden by the Earth's shadow when the Earth passes between the Moon and the sun.

Magnify
To make something appear larger.

Mars
The fourth planet from the Sun. It is the second smallest planet in the solar system, and is about half the size of Earth. Often called the Red Planet.

Mars Rover
A space vehicle designed to travel on the surface of Mars to retrieve or send scientific information.

Space Words

Martian
A fictional creature from the planet Mars. Also, something from the planet Mars, such as Martian soil.

Microbe
A life form that can only be seen with a microscope. Bacteria and viruses are microbes.

Milky Way
The galaxy that contains the Earth, the Sun, and the solar system. It can be seen in the night sky as a long, cloudy group of stars.

Mission
An important task that one is sent out to do. A space mission is a journey into space (unmanned or with a crew) for a specific reason - usually to gather scientific information.

Moon
A natural satellite that orbits a larger object. Earth has one Moon, the one we see in the night sky.

Olympus Mons
The largest volcano in the solar system and located on Mars. It is almost 3 times taller than Mt. Everest!

Orbiter
A spacecraft designed to move around (orbit) a planet or moon.

Phobos and Deimos
The two small, rocky moons orbiting around Mars; they look like asteroids.

Polar ice cap
Dome-shaped sheets of ice found at the north and south areas (polar regions) of a planet.

Nebula
A cloud of dust and gas found in interstellar space. They are sometimes called “star nurseries” because stars are created there.

Space Words

Objective lens
The lens that gathers light from the object being looked at and focuses the light rays to produce an image.

Orbit
The curved path followed by an object in space as it goes around another object; to travel around another object in a single path.

Orion
A large winter constellation in the northern sky. In Greek mythology, a hunter.

Planet
A celestial body that (1) is in orbit around the Sun, (2) has sufficient mass to have a nearly round shape, and (3) it is the dominant body in its orbit.

Polaris (North Star)
A bright star in the constellation Ursa Minor (Little Dipper). It seems to remain in a constant position in the sky; for this reason, Polaris is used for navigation.

Refract
To bend as you move from one medium to another. Example: The movement of air and dust in the atmosphere bends, or *refracts,* a star's light in different directions.

Rocket
A flying device, shaped like a tube, that is pushed by hot gases released from engines in its rear. Rockets are used to launch spacecraft.

Revolve
To move in an orbit or circle around a fixed point. The Earth revolves around the Sun.

Rotate
To turn around a center point — or axis, like a wheel turns on a bicycle. The Earth rotates from day to night.

Satellite
An object that orbits another object. A moon is a natural satellite.

Space Words

Scale
Scale is the implied relationship (or ratio) between a model and the actual object. A scale model is a representation of an object that is larger or smaller than the actual size of the object being represented.

Scintillation
A spark, flash, or twinkle of light.

Solar system
The Sun and all of the planets, comets, asteroids, and other space bodies that revolve around it.

Star
A giant ball of hot gas that emits light and energy created through nuclear fusion at its core.

Sun
The star in the center of our solar system. Like all stars, the Sun is composed of a great burning ball of gases. It is made of 92.1% hydrogen and 7.8% helium.

Telescope
An instrument that uses lenses and mirrors to make far away objects look larger and closer to us.

Terrestrial
Earth-like. A terrestrial planet has a solid rocky surface, with metals deep in its core.

Thrust
To push or drive something with force.

Velocity
The rate of speed or motion.

Volcano
A hole (vent) in a planet's surface that releases lava (melted rock) and gases to the surface.

Space Rangers Name Cards

Make copies of these name tags and let child each choose their own Space Ranger name. They can select from the Space Words list (Orion, Asteroid, Comet, Curiosity?) or adopt the name of an astronomer or astronaut.

My Space Ranger name is: ____________ 	My Space Ranger name is: ____________ 
My Space Ranger name is: ____________ 	My Space Ranger name is: ____________ 

Space Rangers

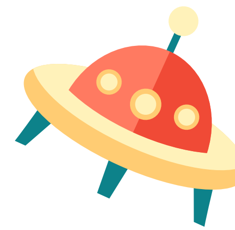
Space Journal

Your name here

Fold cover along dotted lines

Space Rangers

This certificate is presented to:



To celebrate your participation in the Space Rangers program!

Date Signature

Growing readers!

Parent tips for raising strong readers and writers from Reading Rockets

Reading Aloud: Fiction Books

The basics

- Take your time and talk about the story and pictures with your child.
- Ask your child questions and let your child ask questions.
- Read with expression to create excitement.
- You don't need to read every word. Keeping your child interested is the goal.

Try "think alouds"

When you share books with your children, they are learning to think and act like good readers — without even knowing it! You can help them get even more from reading time when you talk to them as you read.

Children learn when they can make connections between what they hear and what they know. One method you can use to help make these connections is called a think aloud, where you talk through your thoughts as you read. Here are three ways to use think alouds, with examples from some of our favorite kids' books.

Connect the book to your child's own life experience

Example: *A River Dream* by Allen Say

"This book reminds me of the time my father took me fishing. Do you remember the time we went fishing?"

Connect the book to other books they have read

Example: *Mufaro's Beautiful Daughters* by John Steptoe

"This story reminds me of Cinderella. Both stories are about sisters. Do you know any other stories about nice and mean sisters? Let's keep reading to find out other ways the stories are similar."

Connect the book to big ideas/lessons

Example: *Stellaluna* by Janell Cannon

"This story helps me understand that we are all the same in many ways, but it's our differences that make us special."

Modeling these types of connections will help young readers know how to do it when they read alone!

Growing readers!

Parent tips for raising strong readers and writers from Reading Rockets

Reading Aloud: Nonfiction Books

The basics

- Wonder out loud. As you are reading (or afterward), talk about facts you find interesting or questions you have.
- Explore the pictures and other graphics in the book, such as charts and diagrams.
- Don’t be afraid to jump around, reading pages that especially interest your child. You don’t have to read a nonfiction book straight through.

Getting the most out of nonfiction reading time

Nonfiction books give kids a chance to learn new concepts and vocabulary, as well as broaden their view of the world. Here’s how to take a “book walk” with a new nonfiction book and how to model active reading.

Take a “book walk”

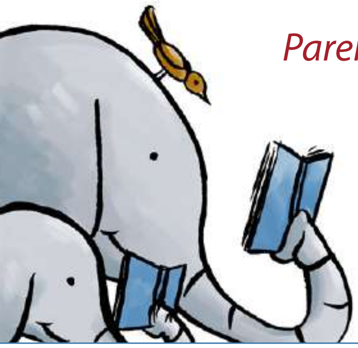
One great way to make predictions about an unfamiliar nonfiction text is to take a “walk” through the book before reading. By looking closely together at the front and back cover, the index, table of contents, the glossary, and the photographs or other images, readers can start to get a sense about the topic. This scanning and skimming helps set the expectation for the reading. Take the time to walk through the book before starting to read.

Encourage questions

A second way to develop more understanding with nonfiction books is to encourage your child to be an active reader who asks lots of questions. Parents can model these behaviors by talking or thinking out loud as you turn the pages of the book. This is a helpful way for your child to see and hear what a successful reader does when faced with difficult or unfamiliar topics.

For example, “When I looked at this photograph, I asked myself, “Where is Antarctica? Is that the same place as the South Pole?” Then talk together about how and what you would need to do to find the answer to the questions. This will reinforce that many questions can be answered by reading a text closely and by paying attention to captions and picture titles. Some children enjoy writing their questions on sticky notes and working to answer them during the reading.

Previewing a text and asking questions are two terrific ways to navigate nonfiction texts. Enjoy spending more time with some fascinating informational books!



Parent tips for raising strong readers and writers

Growing readers!

Brought to you by Reading Rockets, Colorín Colorado and LD OnLine

Literacy in the Sciences: Activity No. 14

How to Read Nonfiction Text

Kids love to read about real people, places, and events. Nonfiction books present real information in engaging and interesting ways. However, most kids read a lot more fiction than nonfiction, so spend some extra time helping your reader learn how to navigate a nonfiction book.

Talk about nonfiction

Begin by explaining that the book you're about to share is nonfiction. That means that the book will give us information that is true. The book will be organized around a specific topic or idea, and we may learn new facts through reading. Some kids even enjoy sorting their home libraries into fiction and nonfiction books. This simple categorization task helps your child understand the difference between fiction and nonfiction.

Look at the parts

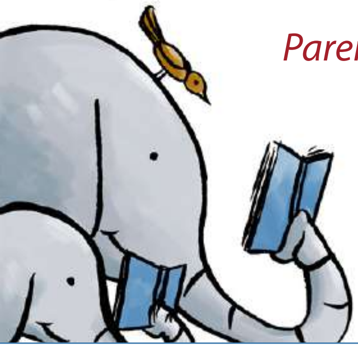
Most good nonfiction books will have helpful features that are not a part of most fiction books. These parts include a table of contents, an index, a glossary, photographs and charts with captions, and a list of sources. Share the purpose of the features with your reader.

- **Table of Contents:** Located at the front of a book, the table of contents displays a list of the big ideas within the book and where to find them.
- **Index:** An index is an alphabetical list of almost everything covered within the book, with page numbers. Readers can use the index to look up specific terms or concepts and go right to the specific information they're looking for.
- **Glossary:** Located at the back of the book, a glossary contains key words that are related to the topic and their definitions. These definitions provide more information about new vocabulary words.
- **Captions:** Captions are usually right under photographs, figures, maps, and charts. Captions give a quick summary of what information is presented in the graphic.
- **Photos and Charts:** A lot of information can be found by "reading" the charts and photos found within nonfiction text. Readers will first need to figure out what information is presented. Then they'll need to discover how to navigate the information. Some charts use clear labels, others require more careful examination. Help your reader learn more about the different ways information can be displayed.

Be the reading boss

Nonfiction books do not have to be read from cover to cover. Readers can use the table of contents and index to jump right to the information they are most interested in. In that way, they are the "reading boss" of that book! However, if your reader wants to read from cover to cover, encourage him to use the table of contents to understand how the book is organized. "First we will learn about the different types of frogs. Then we'll learn where they can live, what they eat, and how they survive." Passages from the book can be reread as often as necessary until your child understands what is written. You can refer to pictures, charts and tables over and over again as well.

As natural learners, young readers are drawn to books that give information about something or explain something they've always wondered about. With a little help and guidance about reading nonfiction, you can feel good about introducing your child to a new world of information.



Parent tips for raising strong readers and writers

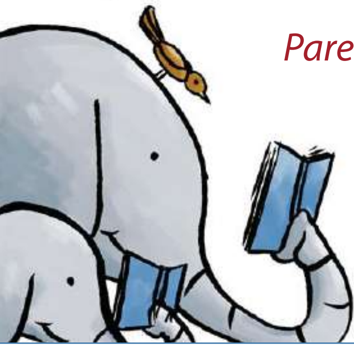
Growing readers!

Brought to you by Reading Rockets, Colorín Colorado and LD OnLine

Summer Literacy Challenge!

For most parents, it's a challenge to keep kids reading and writing all summer. Suddenly 10 weeks of summer can feel like a very long time! We've got a summer literacy challenge for you and your child. It's modest enough to be manageable –pick just one thing a week to kick start your week's literacy adventures. But it's also challenging enough to include a wide range of literacy fun for the whole family.

- ✔ **Investigate your public library's summer reading program.** Most libraries offer a special program or two during the summer, including puppet shows, book authors and children's storytellers. Most are free of charge.
- ✔ **Extend your reading circle.** We often find ourselves checking out the same types of books over and over again. This week's challenge is to bring a new type of book into the house. Consider fantasy or science fiction, historical fiction, poetry, biography, or an informational book.
- ✔ **Listen up!** Audiobooks are a great way to engage readers and can introduce students to books above their reading level. Many libraries have audiobooks available for check out, and an Internet search can turn up several sites, including Speakaboos.com, that offer free audio books for children.
- ✔ **Make your own audio book!** Most phones and computers have simple recording apps on them which are perfect for making homemade audio books! Have your child make up a story, or reread a favorite loved book. The recordings will be priceless!
- ✔ **Go wordless.** Wordless picture books are told entirely through their illustrations — they are books without words, or sometimes just a few words. Grab a few wordless books the next time you're at the library and have fun "reading" different versions of the same story. The language and the conversation will inspire you!
- ✔ **Visit a museum, online!** You'll be surprised by how much you can explore without leaving your house. One example is the Smithsonian Institution Kids site. It's complete with offerings from Art to Zoo, for kids and students of all ages.
- ✔ **Pack in a whole adventure!** Find FREE themed reading adventure packs that encourage hands-on fun and learning, centered around paired fiction and nonfiction books. Visit Reading Rockets and search Adventure Pack.
- ✔ **Point, shoot, and write.** Most families have access to a digital camera, iPad or camera phone. Snap some photos and then encourage your child to write a silly caption for each photo. Not feeling that ambitious? Cut out some pictures from a magazine or the newspaper and have your child write original captions for those.
- ✔ **Mix up the media.** Your child has read every Clifford book on the shelf. But has she heard Clifford author Normal Bridwell talk about writing? Explore author interviews from over 100 authors on Reading Rockets Author Interview page. We'll bet you can't watch just one.
- ✔ **Write it down.** Encourage your child to keep a simple journal or summer diary. Track interesting things like the number of fireflies seen in one minute, the number of mosquito bites on a leg, or the different types of food that can go on the grill. Each entry is a chance to be creative!



Parent tips for raising strong readers and writers

Growing readers!

Brought to you by Reading Rockets, Colorín Colorado and LD OnLine

Literacy in the Sciences: Activity No. 4

Making Predictions

As a young reader, your child is learning to make predictions while reading. "What do you think will happen next?" "Who do you think drank Sara's lemonade?" These types of questions we ask children as they're reading help them learn to monitor their understanding of the story while thinking ahead to the next part. If your child is able to make good and fairly accurate predictions while reading, chances are she comprehends the story well.

Scientists, just like readers, make predictions all the time. In fact, scientists use predictions as part of their hypothesis, or question they try to answer through their experiments. Help your child begin to see the connection between what she does as a reader and what she can do as a scientist.

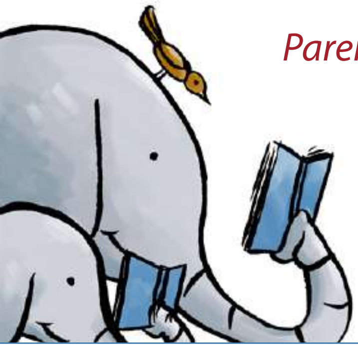
Below are two simple ways you can encourage your child to put her prediction skills to work as a scientist:

1. **Play favorites.** What is our family's favorite flavor of ice-cream? What is our favorite movie to watch together? What is our favorite bedtime story? Choose a question, or make up your own, that your child is excited about. First, have your child predict or guess the answer to the question. Help her write down her prediction. "I think chocolate is our family's favorite flavor of ice cream." Then, have your child ask each member of the family for an answer. Have your child record the answers using a special Science Notebook or simply mark tally marks on paper. Finally, ask your child to compare her prediction to the actual answers.

2. **Good guess!** Estimation is often very similar to a prediction. In both cases, your child will be working to make a good guess about an answer. As with our Play Favorites idea, encourage your child to write down (or write together) the questions and answers in a special Science Notebook. Whenever possible, encourage the use of scientific words like estimation, predication, collect data, analyze, and prove. Here are some estimation questions that require your child to make a prediction:

    - How many noodles will it take to fill up this jar? Encourage your child to use scientific language and thinking to answer. "I predict it will take 300 noodles to fill the jar."
    - How many steps is it from our front door to the mailbox?
    - How much does our dog weigh?
    - How many library books fit on one shelf?
    - How long do you think it will take for the ice cubes to freeze (or melt)?

We predict your child will have great fun with these activities! And you can have fun knowing that you're helping your child make important connections between the skills of prediction, reading, and science.



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Literacy in the Sciences: Activity No. 11

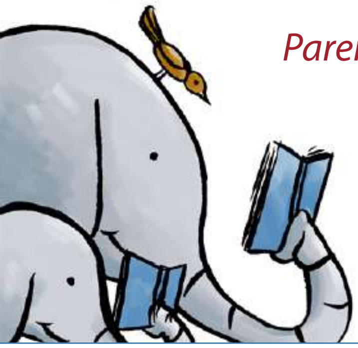
Making Inferences and Drawing Conclusions

Observations occur when we can see something happening. In contrast, inferences are what we figure out based on an experience. Helping your child understand when information is implied, or not directly stated, will improve her skill in drawing conclusions and making inferences. These skills will be needed for all sorts of school assignments, including reading, science and social studies. Inferential thinking is a complex skill that will develop over time and with experience.

Families can create opportunities to practice inferential thinking. Below are a few ways to help familiarize your child with this way of thinking and learning:

- Explain to your child that we make conclusions about things and draw inferences all the time. Draw a conclusion together and then talk about what clues were used to come to that conclusion. For example, Erin played outside today. How can we tell? Muddy shoes, jump rope on front porch, water bottle out. Dad seems tired tonight. How can we tell? He's rubbing his eyes, he's on the couch, he was yawning at the dinner table.
- Paper bag mystery person: Put a few items into a brown paper bag. Tell your child the bag belongs to a certain type of person. Their job is to tell you something about the person. Then, take out each item one by one and talk about it.
  - Example #1: goggles, a swim cap, a swim ribbon, a stop watch
  - Example #2: a bookmark, a library card, a stuffed animal, a book
- Wordless picture books provide your child with practice using clues to create meaning. There are no wrong stories with wordless picture books, only variations based on what the "reader" sees and puts together. *Rosie's Walk* (Hutchins), *Good Dog, Carl* (Day), and *Beaver Is Lost* (Cooper) are all interesting and fun wordless picture books to explore.
- Play twenty questions! This familiar word game helps build inference skills. As your child develops skill with the game, encourage him to avoid asking direct questions like, "Is it a dog?" Rather, encourage him to ask broader questions, "Does it walk on four feet?" Then, when your child figures it out, ask him to tell you the clues that lead to the right answer.
- Create scenarios in which your child must use what they already know to predict an outcome. For example, growing seeds. Present your child with various scenarios (a seed will be given water and sunlight, a seed will get no water, a seed will be in a dark room). Ask your child to predict whether the seed will grow. Help your child become aware that she used information she knew about growing seeds, combined with new information, to fill in information about the seeds.

Learning to draw conclusions and inferences is a skill that develops over time. The skill requires children to put together various pieces of information, and relies on good word knowledge. Help your child develop skill by providing experience with inferential information, making implied information more clear, and helping your child draw conclusions based on the evidence.



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Literacy in the Sciences: Activity No. 6

Recording Observations

Science and math explorations provide your growing reader with a chance to record all kinds of observations. Young children love to keep a special journal, and fill it with all sorts of drawings, scribbles, sketches, notes, and graphs. Try to date each entry and watch as your child's observational and recording skills grow along with your child.

Create a special journal

Use any paper for the cover: cardstock, interesting cardboard and pretty greeting cards can all be used as a cover. Then, collect some twigs from the backyard and find a large, thick rubber band. Fold your cover in half. Fold your inside pages, and put them inside the cover. Trim as needed. Punch two holes with a hole punch, measuring down from the top and up from the bottom about 2 inches. Pull one end of the rubber band through the bottom hole and slide twig into the loop. Pull the other end of the rubber band through the top hole and slide the other end of twig through that. You now have a special journal into which your budding scientist can record observations.

A scientist's field notes

Begin using the science journal by taking your child outside. Encourage your child to write down what she observes about her surroundings, looking at both the big picture and the small, examining plants and rocks and insects up close. Have her make a record in their journal of what they experience with each of their senses. Then have her choose one animal or plant to watch for 10 minutes. Your child can choose anything: a dandelion, a grasshopper, a bird soaring overhead. Ask her to describe it as clearly as they can, as if she is writing for someone who's never seen that before. Have her watch for movements and take note of any sounds made. Ask your child to draw and label a picture of the plant or animal.

Other fun ideas to record in your field journal

A flower tally: Count the flowers in an area in the spring once a week for three weeks. Compare your tallies. Your child will have fun watching the numbers go up as flowers bloom in the spring.

Ant watching: There are ants everywhere! Try following them to their home and see what they're up to. Where do they live? How many can you count in one place? Record these observations and your ant grand total.

Dig a hole: As parents know, dirt can be pretty interesting to kids. Have your child dig a hole and notice how the dirt changes as he digs deeper. Can he describe the different layers? What creatures did he find as he dug? Record these and other interesting findings in the journal.

Nature scavenger hunt: Use your notebook to make (or draw) a list of some common things and a few rare ones that can be found outside near your home or in a park. Include things like: acorn, pine cone, flat rock, bird feather, weed, flower. Hand your child the notebook and let the scavenger hunt begin!

Special thanks to the Two Writing Teachers (www.twowritingteachers.wordpress.com) for their field journal directions, and Nature Rocks (www.naturerocks.org) for the nature-based ideas for family fun.