



National Park Service
U.S. Department of the Interior

Night Sky Program

An explorer's activity guide
for ages 5 to 12

Junior Ranger Night Explorer





How to become a Junior Ranger Night Explorer

Ask a Ranger if the park will have an astronomy program or telescope viewing while you are visiting. If they will, attend one of these programs.

If not, make sure to do the “Take a planet walk” activity found within this book.

How old are you? ____ That is the number of activities you must complete to become a junior ranger night explorer, but feel free to do more.

Each activity is rated by difficulty:

- ★ ages 5 and up.
- ★★ ages 8 and up.
- ★★★ are the most challenging.

Look for the star ratings throughout the book and choose the activities that are right for you!

Also be sure to check out the *bold italic* words and their definitions throughout the book.

EXPLORE • LEARN • PROTECT



2010. Junior Ranger, Night Explorer. An explorer's activity guide for ages 5 to 12.
Night Sky Program, Natural Resources Program Center, National Park Service

Cover photo — The Milky Way above Long's Peak, Rocky Mountain National Park, by Tyler Nordgren.

Content — Claire Thoma, Chad Moore, Teresa Jiles, and Angie Richman.

Graphics — Chad Moore, Lisa Lynch, and Richard Kohen.

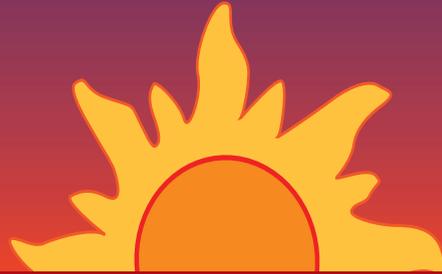
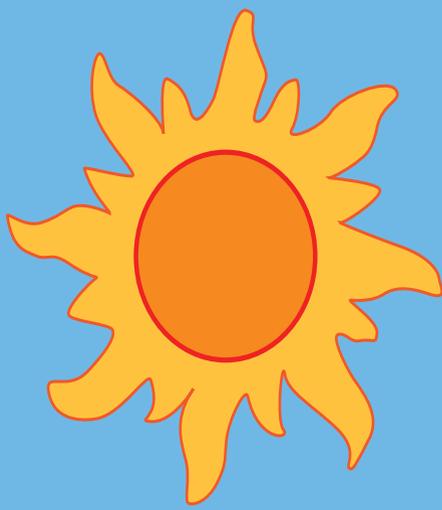
Layout & design — Richard Kohen and Angie Richman.

Hand model — Laura Kohen, age 10.

Images — Courtesy NASA image archives.

Planisphere — Use of the planisphere courtesy National Research Council Canada.

Support has been graciously provided by Curecanti National Recreation Area, the NPS Office of Interpretation and Education—Intermountain Region, and the Student Conservation Association.



Exploring with your senses

The 24-hour pattern of light— day, sunset, night, and sunrise affects the daily rhythm of all living things. Most humans go to sleep when it is dark, but there are many creatures that wake up when we go to bed.

In fact, there is an entire *nocturnal* ecosystem that is an important part of nature. These nocturnal animals have adapted to the night. For example, bats bounce sound waves off objects to fly in the dark and catch insects. Deer, owls, and mountain lions have large eyes to let in more light, and can see just fine by starlight.

Nocturnal
describes an animal
that spends its “days” at
night.

DAY

SUNSET

My observations

Spend some time outside in the park during the day, as the sun is setting, and at night. Record the differences in what you see, smell, and hear at each time of day.

- ★ Record one sense.
- ★★ Record two senses.
- ★★★ Record three senses.

NIGHT



Astounding Sun

Our sun, which is named “Sol,” is the nearest star to us and is the brightest star in the sky. Like all stars, Sol is a giant ball of boiling gas. It is so big that one million Earths can fit inside!

Prominences
Activity on the Sun where super-hot gas is shooting off of the surface and then falling back down in an arc or loop.

Sunspots are areas where the surface of the Sun is a bit cooler, which will appear darker than the rest of the surface.

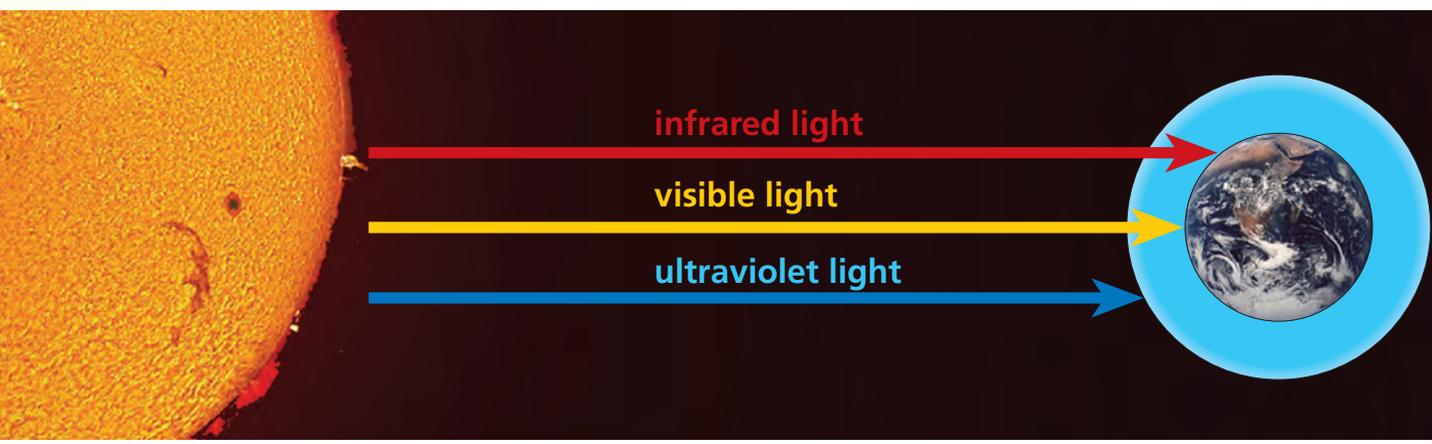
Ultraviolet light is light from the Sun or stars that we cannot see with our eyes because it is so blue. This is the type of light that gives you a sunburn!

Infrared light is light from the Sun or stars that we cannot see with our eyes because it is so red.

Special telescopes and satellites that are made for looking at the sun show us that its surface is always changing. Surface explosions called *prominences* shoot hot gas into space and *Sunspots* appear as dark spots. Over time they will change places on the surface of the sun.

Remember, never look directly at the sun!

The sun shines light in all the colors of the rainbow. It also shines other types of light like *ultraviolet* and *infrared*. Our eyes cannot see ultraviolet light, but we know it exists because it will burn our skin if we stay outside too long without sunscreen. Other types of light from the sun are even more harmful. Luckily for us the Earth is protected by an atmosphere that contains ozone, which blocks ultraviolet and other harmful types of light.



- ★ Label a sunspot, a prominence, and the ozone layer on the picture above.
- ★★ Label the above diagram, and think of another type of light that the atmosphere blocks. (Hint: It is used in hospitals to look at your bones!) What is it? _____



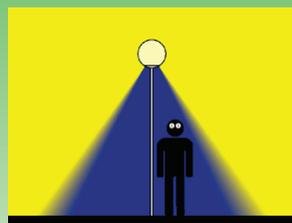
Lights Down, Stars Up!



This lamp protects the night sky and animals by only shining light down to the ground.



This lamp wastes light and beams it into the sky: it goes everywhere!



This lamp shines light everywhere **except** where it is needed: on the ground.

Humans are creatures who have adapted to do most of our activities during the day. When we do things at night, we need light. But, light is a tool we must learn to use responsibly. Outdoor lamps are often too bright or point up into the sky. They add to *light pollution*, and when light pollution is really bad, we cannot see the stars, and nocturnal animals often get disoriented and confused.

Light pollution is the brightening of the night sky by man-made lights that direct light up (like some streetlights and billboards).



★ Draw an "X" over wasteful lamps and circle good ones.
★ Draw a triangle around one that is like what you see at this park.

What do the lamps at your home look like?

Nocturnal animals

★★ Draw a line from each picture to its description.

★★★ What can you do to help the nocturnal animals where you live? _____

Bat



My hatchlings emerge from the sand and know to crawl toward the brighter whitecaps on the ocean, but light pollution can send them in the wrong direction.

Salamander



I am unable to resist being drawn to a light, and may fly for over a mile to your porchlight.

Moths



I used to find my favorite foods- moths and gnats- everywhere I flew. But now I must commute much further to the city for my dinner.

Firefly



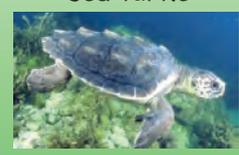
I crawl from pond to pond with a compass in my head keeping me on course. But too much light turns me around, and I can't find my watery home.

Warbler



Lights from tall buildings and houses confuse me during migration each fall. I must be careful, or I can crash into one of those shiny bright windows

Sea Turtle



My flickering tail will attract a mate, but only if she can see me among the many streetlights.



How dark is the sky?

Limiting magnitude is a measure of the darkness of the night sky based on the faintest star that can be seen with your eyes.

The stars are always there, but we cannot always see them. The farther away from sources of *light pollution* you are, the more stars you can see. Astronomers measure the darkness of the sky in something called *limiting magnitude* where 7 is the best and 0 is the worst. Follow the directions below to estimate how dark the sky is at this park.

★★ Below are pictures of how many stars you can see at different limiting magnitudes. Choose the picture you think best matches the sky at this park and circle it.

(Hint: If it's summer, use the Big Dipper. If it's winter, use Orion. Also use the star wheel in the center of the book to help you find these constellations.)

Big Dipper



Magnitude 2



Magnitude 4



Magnitude 6



Magnitude 7



Orion

★★★ When you get home, choose the picture you think best matches the sky from your backyard. What do you think the limiting magnitude is at your home? _____

Can you see more or fewer stars at your home? Why do you think this is? _____



New Moon



Waxing Crescent



First Quarter



Waxing Gibbous



Full Moon



Waning Gibbous



Third Quarter



Waning Crescent

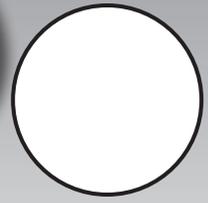
Orbit is the path, usually an oval, of a moon around a planet or a planet around a star.

Changing faces of the Moon

It takes 28 days for the moon to complete one *orbit* around the earth. As it travels around our planet, different sections of it are lit up. When the whole face of the moon is lit, it is called "full." When none of the moon is lit, it is called "new."

While the moon is growing from "new" to "full," it is described as "waxing."

When the moon is shrinking from "full" to "new," it is called "waning."



- ★ Go outside and find the moon. Shade in the shadowed part.
- ★★ What phase is the moon in now? _____
- ★★★ Predict the number of days until the next full moon: _____

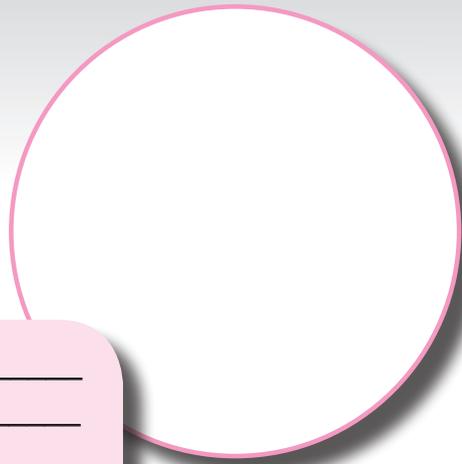
Telescope eyes

If possible, attend an astronomy program and telescope viewing.

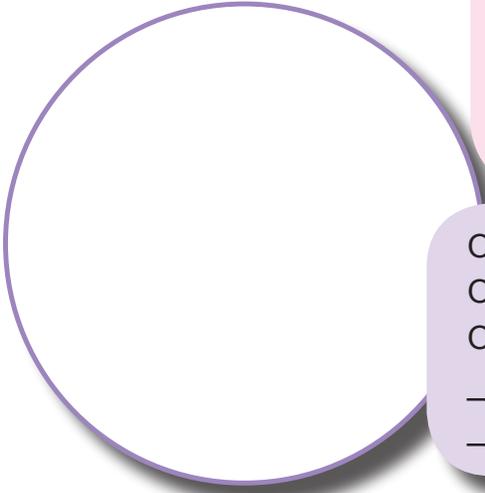
★ Look through a telescope. In a circle (below), draw what you can see in the *field of view*.

★★ Ask the telescope operator to tell you about the object, and write down what you learn.

★★★ Look at a second object in the telescope and repeat the activity.



Object name: _____
 Object type: _____
 One thing I learned about this object: _____



Object name: _____
 Object type: _____
 One thing I learned about this object: _____

Field of view is the piece of sky you can see through a telescope.



Using a planisphere



Constellations
are groups of stars that make a
picture in the sky.

★ Cut out the star wheel (planisphere) below and the holder (on the next page). Carefully cut out the middle of the holder. Fold the flaps on the holder back, and insert the star wheel. Turn the wheel until the date appears above the time that you are out at night. The **constellations** visible at that time appear in the window.

Face South and hold the planisphere above your head and look up at it. The constellations in the middle of the oval should be directly above your head (at the zenith). The constellations on the **left side** of the oval should be to your left on the eastern horizon. The constellations on the **right side** of the oval should be to your right on the western horizon. The stars on the **bottom** of the wheel (South) should be directly in front of you, and those on the **top** of the wheel (North) should be behind you.



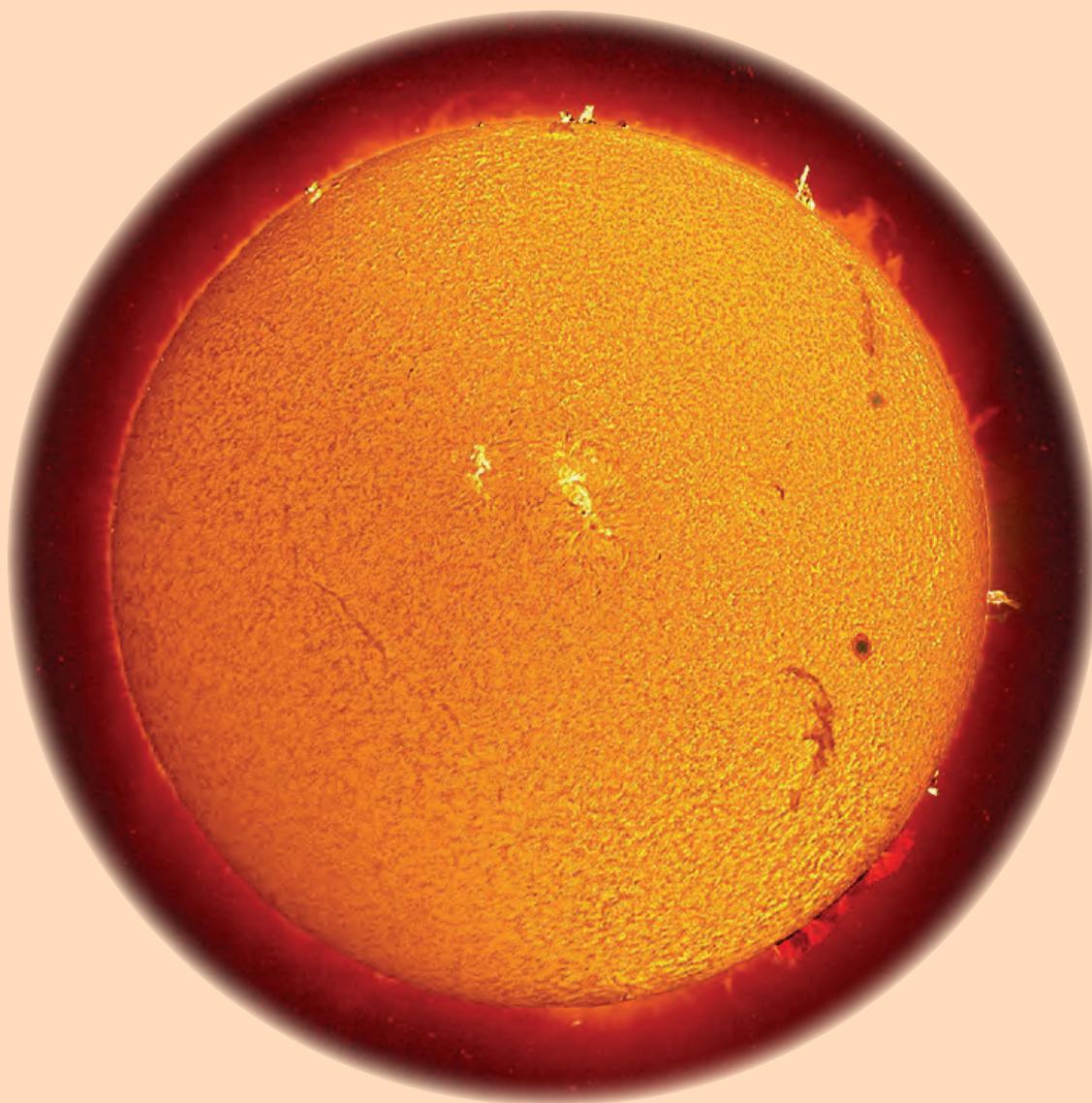
Use scissors to cut out the planisphere. Cut just outside the thick border.



Did you notice?

The stars in the upper corners change color from page to page. Stars come in many different colors, and their color tells us what temperature they are. Hotter stars are blue, while ones that aren't so hot are red. Our star, the sun, is yellow, and is a medium temperature star. Really really hot stars shine in ultraviolet light, while those that are only warm emit energy as infrared light.

A star can change color by changing its temperature. As stars grow older they often cool down in temperature and thus may appear more red. By studying the colors of stars, astronomers learn about their birth, life, and death. Check out the Star Formation Jumble to learn more.

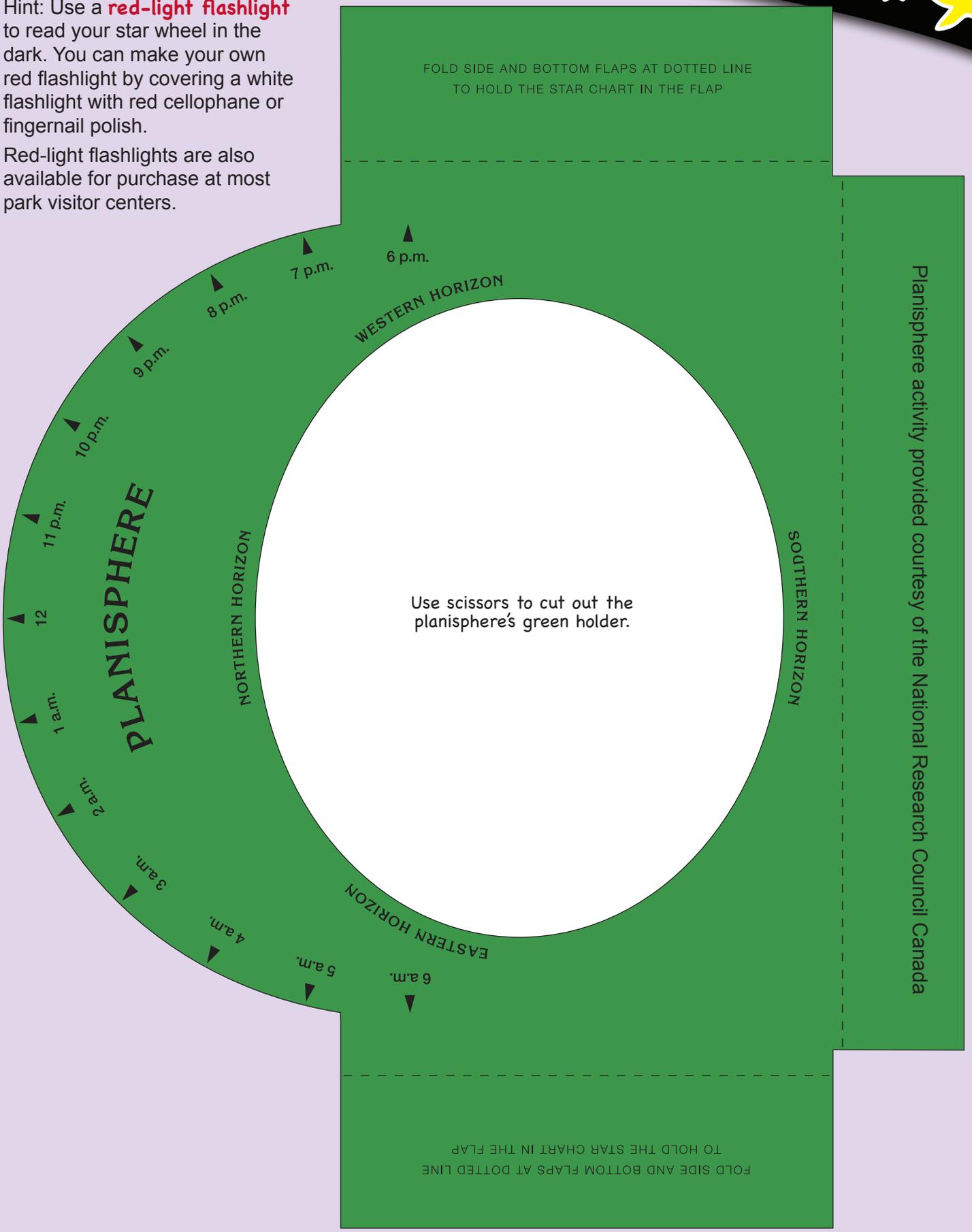


Our sun is the nearest star to us. Its surface temperature is 10,000°F!



Hint: Use a **red-light flashlight** to read your star wheel in the dark. You can make your own red flashlight by covering a white flashlight with red cellophane or fingernail polish.

Red-light flashlights are also available for purchase at most park visitor centers.



Use scissors to cut out the planisphere's green holder.

FOLD SIDE AND BOTTOM FLAPS AT DOTTED LINE TO HOLD THE STAR CHART IN THE FLAP

FOLD SIDE AND BOTTOM FLAPS AT DOTTED LINE TO HOLD THE STAR CHART IN THE FLAP

Planisphere activity provided courtesy of the National Research Council Canada

PLANISPHERE

NORTHERN HORIZON

WESTERN HORIZON

EASTERN HORIZON

SOUTHERN HORIZON

6 p.m.

7 p.m.

8 p.m.

9 p.m.

10 p.m.

11 p.m.

12

1 a.m.

2 a.m.

3 a.m.

4 a.m.

5 a.m.

6 a.m.



Earth—our home planet

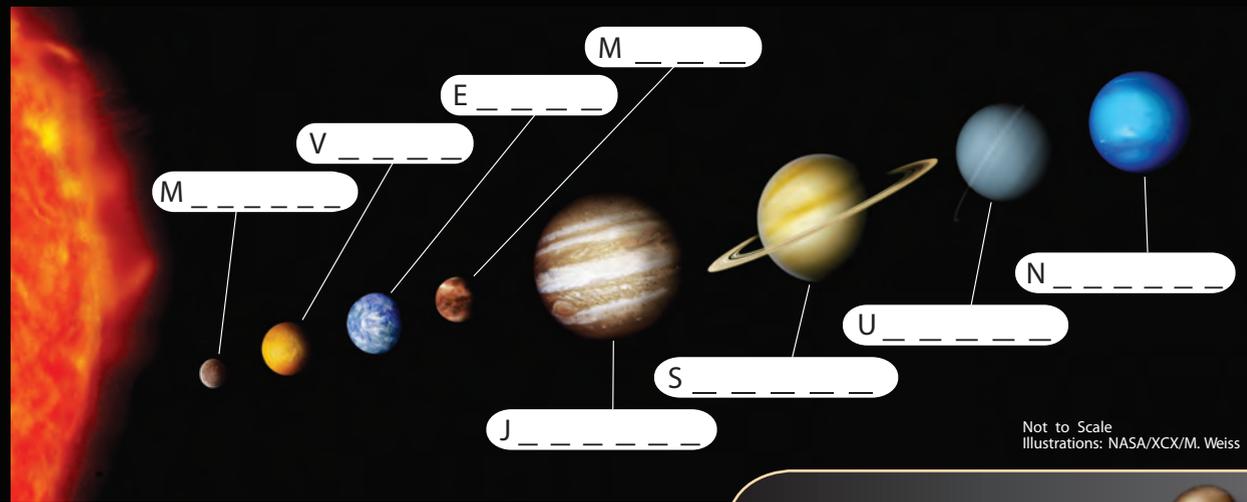


Solar system smarts

★ This is a picture of our solar system. Label each planet in order of their location from the sun.

Planets

- Saturn
- Uranus
- Earth
- Neptune
- Venus
- Jupiter
- Mercury
- Mars



Not to Scale
Illustrations: NASA/XCX/M. Weiss

★★ Create a **mnemonic** to help you remember the order of the planets: _____

A mnemonic (pronounced "ne-mon-ic") is a sentence in which the first letter of each word is the same as the first letter of the words you are trying to remember. For example, to remember the first four moons of Jupiter (Io, Europa, Ganymede, Callisto), many students remember the phrase, "I Eat Green Caterpillars."

Where is Pluto?



In 2007, scientists changed the definition of a planet, and Pluto ended up moving from the category of "planet" to the category of "minor planet" because:

- 1) Pluto has an irregular (not circular) orbit; and
- 2) Pluto did not clear its orbital path of debris.

Based on these definitions, scientists either had to demote Pluto or add several more planets to our solar system.

Take a planet walk

★★★ Start at a trailhead and pretend you are starting at the sun. While you walk, the planets' distances from the sun would be the number of steps you take. Place a rock or other object in the location of each planet. This walk is a total of **484 steps**. The sun would be the size of an apple and the earth the size of the point of a pin on this scale.

- 4 steps:** you are at Mercury
- +4 steps:** you made it to Venus
- +4 steps:** you have reached Earth
- +6 steps:** you are at Mars
- +45 steps:** welcome to Jupiter
- +54 steps:** you have arrived at Saturn
- +118 steps:** you are at Uranus
- +134 steps:** you have reached Neptune
- +115 steps:** you made it to Pluto!



Navigating at night

For over a thousand years, sailors have used the stars to find their way across the ocean on long voyages. As the earth rotates, all of the stars appear to spin around a point called the Celestial Pole. Because the star Polaris (also called the North Star) is very close to the Celestial Pole, it is the only star that does not appear to move during the night. Its *altitude* is equal to the observer's *latitude* (these distances are measured in degrees). Sailors could find their latitude by measuring how far above the horizon the North Star appeared. To test your own skill at navigating by the stars, go outside at night, and use the chart below to find Polaris. Now hold your arm out straight and level to the ground. Make a fist with your thumb resting on top of your first finger. Starting with the base of your fist straight out in front of you, count how many fists you need to reach Polaris.

Altitude is the height that an object appears above the horizon. An object on the horizon has an altitude of zero degrees, and an object directly overhead has an altitude of 90 degrees.

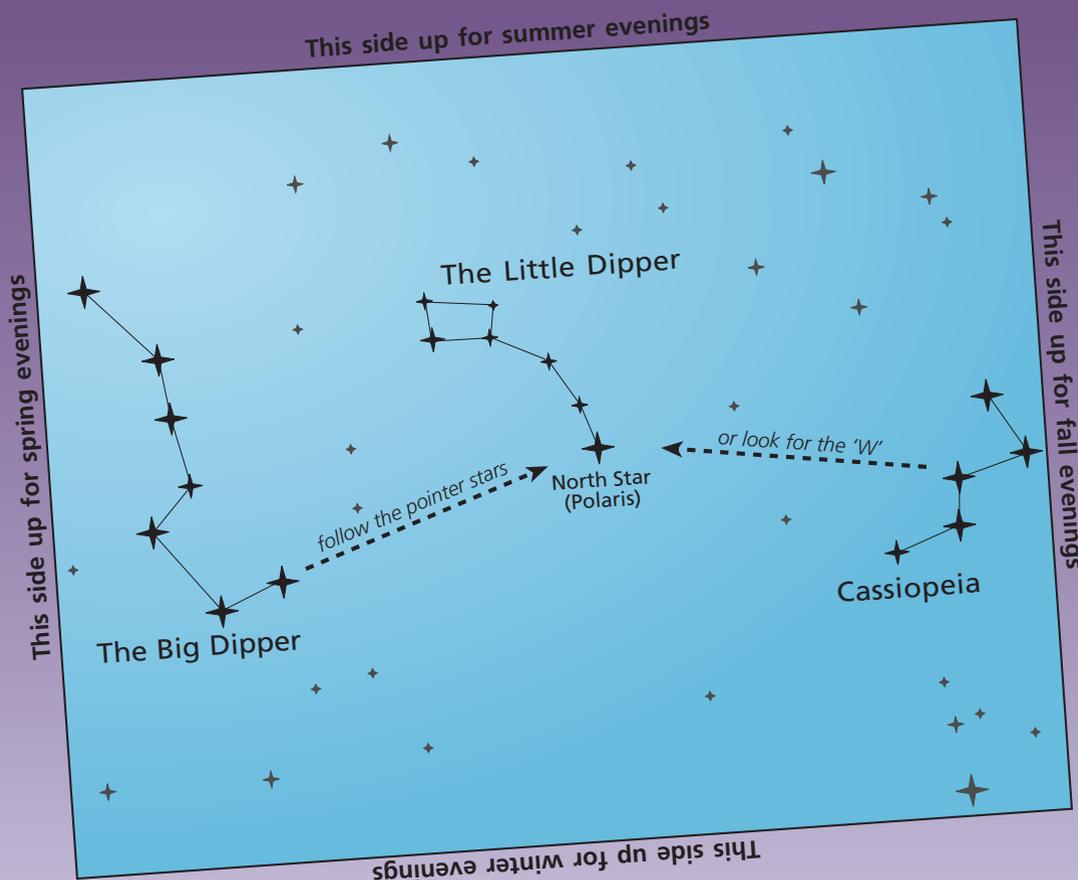
Latitude is the distance from any point on the Earth to the equator. The equator has a latitude of zero degrees, and the North Pole has a latitude of +90 degrees.

★ Look for the North Star in the sky. Did you find it?

★★ Use the estimate that one fist is about 10 degrees. What is your latitude?

★★★ Look at a map or ask an adult to help you find your exact latitude.

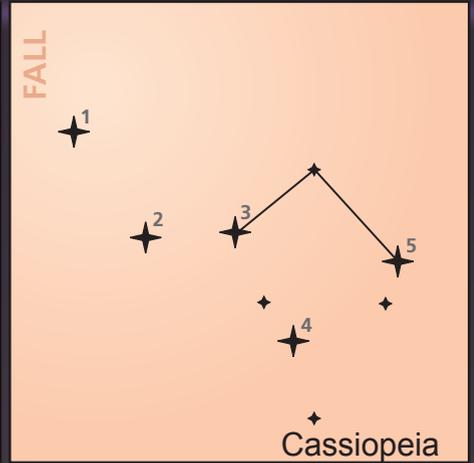
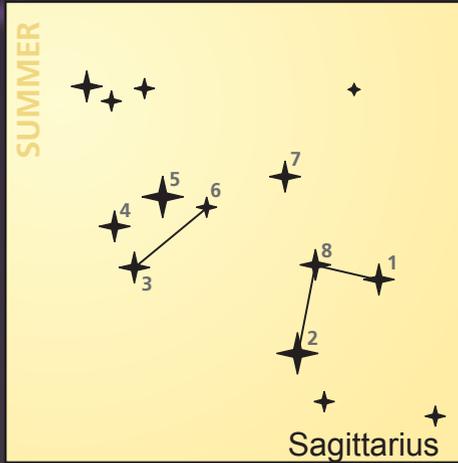
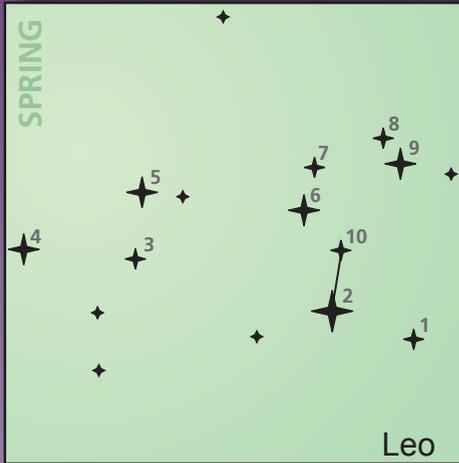
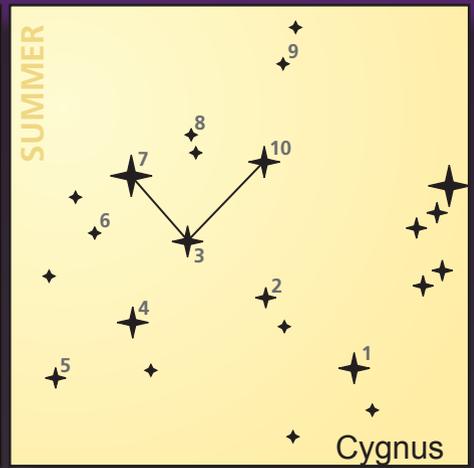
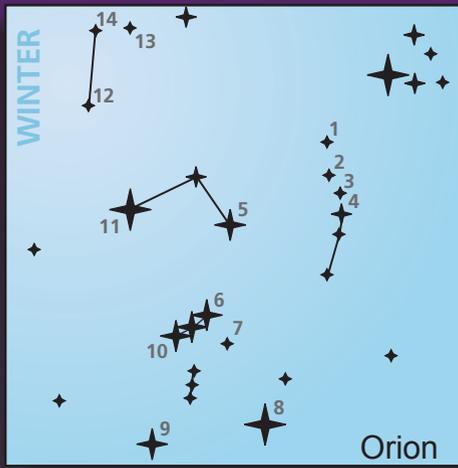
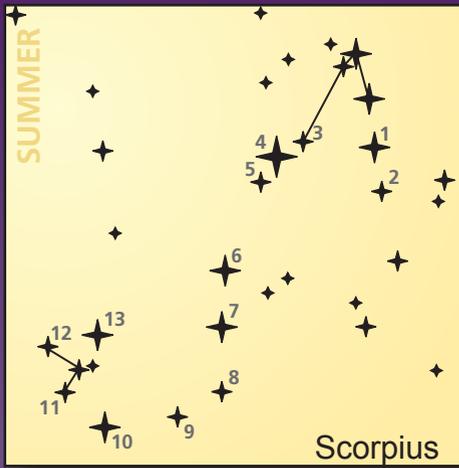
How close were you?



Constellation riddles



- ★ Draw the shape of each constellation by connecting the numbered stars in order.
- ★★ Connect the stars and write the name of each constellation next to its story below.



I am a mighty hunter. I hunt with a bow and carry a sword in my belt. I am usually seen during the winter because I stay away from my enemy, the scorpion, who is visible in the summer. **Who am I?....**

_____ n

I am a lion with a bright heart. Although I am lying down right now, I am still a fearsome beast seen during the spring and summer. **Who am I?....**

I am the scorpion whose powerful claws and stinger chase the hunter across the sky. I am on a mission to chase him forever. I am seen in the southern sky during the summer. **Who am I?....**

_____ p _____

I am a beautiful queen whose pride almost killed my daughter, Andromeda. I can be seen sitting in my “W”-shaped throne in fall, but as punishment for my pride I hang upside down half of each night. **Who am I?....**

c _____

I am half horse and half man, although now people often refer to me as a “teapot.” I tutored the great heroes Achilles and Hercules. I guard the southern sky in summer. **Who am I?....**

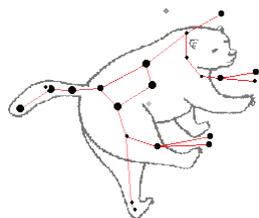
_____ g _____

I am a swan, and I gracefully glide down the Milky Way during summer and fall. I am sometimes known as the “Northern Cross.” **Who am I?....**

c _____



Same stars, different stories



Bear

People around the world have different meanings for the shapes they see in the stars. The constellation we know as the Big Dipper was known to both Native Americans and Greeks as a big bear. To farmers in England, it was known as a plow, and to fishermen in



Plough

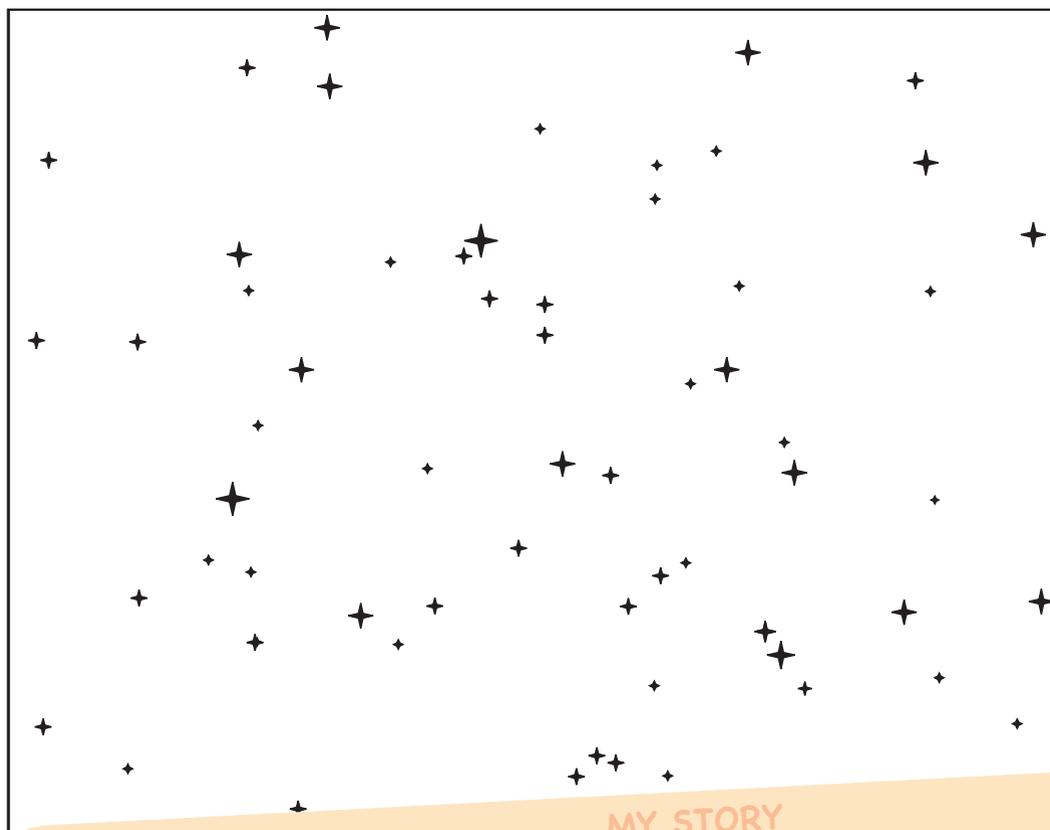
Australia, it was known as a canoe. In Germany it is called a big wagon, Arabians saw a coffin followed by three mourners, and the Chinese knew it as a grain measure. People see objects that are important to their daily life in the stars.



Canoe



Grain measure



★ Using the starfield to the left, connect some stars to make your own constellation.

★★★★ *Make up a story, about your constellation.*

MY STORY



Deep-sky match

- ★ 3 matches
- ★★ 5 matches
- ★★★ 8 matches

Draw a line from each picture to its description.

Globular cluster



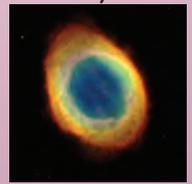
Many galaxies living in the same neighborhood

Spiral galaxy



Ball of ice and dust that passes by Earth and often has a "tail" of gas streaming out behind

Planetary nebula



Group of tightly packed old, yellow stars

Asteroid



Two stars that orbit each other

Gas left behind when a star's core collapses (through old telescopes, it looked round like a planet)

Comet



Thick cloud of gas from which new stars can form

Star-forming nebula

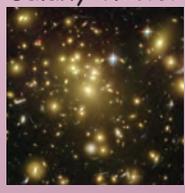


Gas, dust, and billions of stars in a flattened shape with spiral arms

Binary star system



Galaxy cluster



Chunk of rocky debris usually found between the orbits of Mars and Jupiter

Scavenger hunt tic-tac-toe

Go out at night, let your eyes adjust to the darkness, and look around. Cross off everything that you find!

- ★ Two
- ★★ Four
- ★★★ Six

Star



Night animal



Moon



Man-made light



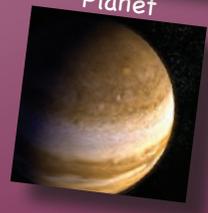
Milky Way



Satellite



Planet



Star cluster



Shooting star

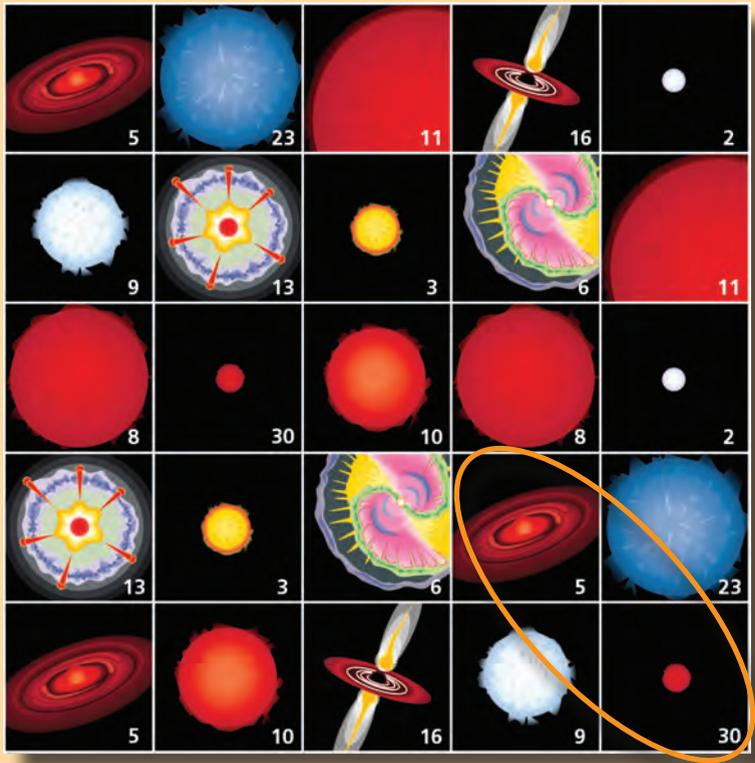




Star formation jumble

Stars have life cycles just like plants and animals! All stars begin from thick clouds of gas and dust. In their first stage, they are called a protostar  and are surrounded by a disk of gas and dust. The size of the star determines what type of life it will lead and how long it will live. **Red dwarf** stars  are smaller than our Sun. Because they live for so long, they have not yet evolved past their first life stage. A **Sun-like star** spends most of its life as a yellowish ball of gas  with burning hydrogen in its core. Once it uses up all its hydrogen, it evolves into a red giant  before its core collapses and leaves the gas behind to form a planetary nebula . Its core then becomes a white dwarf  and slowly cools. A star a bit larger than the Sun will live as a **white giant**  and evolve into a red supergiant , and then explode in a supernova . A star much larger than a white giant will spend its short life as

a **blue supergiant**  that evolves into an even bigger red supergiant . It finally collapses into a powerful black hole . All of the gas that gets sent out into space by supernovae and planetary nebulae eventually forms clouds of gas and dust that become nurseries  for new stars, and the cycle continues.



★★★ In the picture jumble on the left, find the sequences that represent the life cycles of each of the four types of stars. The sequences may be vertical, horizontal, or diagonal. Write the number found in the corner of each picture in the blanks below and do the math (addition and subtraction) to discover how long each star will live.

Red Dwarf: $\underline{\quad} + \underline{\quad} = \underline{\quad}$ Billion years

Sun-like Star: $\underline{\quad} + \underline{\quad} + \underline{\quad} - \underline{\quad} - \underline{\quad} = \underline{\quad}$ Billion years

White Giant: $\underline{\quad} + \underline{\quad} + \underline{\quad} + \underline{\quad} = \underline{\quad}$ Million years

Blue Supergiant: $\underline{\quad} + \underline{\quad} - \underline{\quad} - \underline{\quad} = \underline{\quad}$ Million years

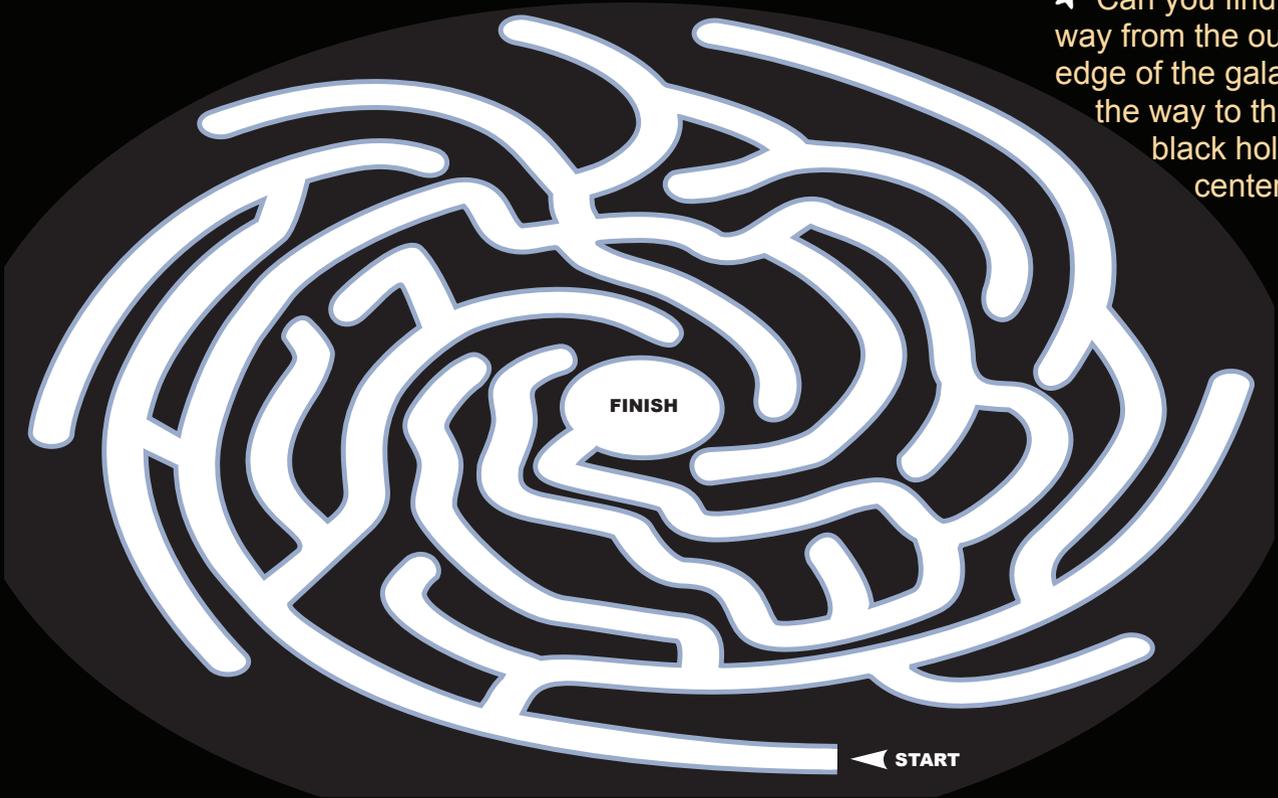
Hint— Red Dwarf star formation has been found for you!



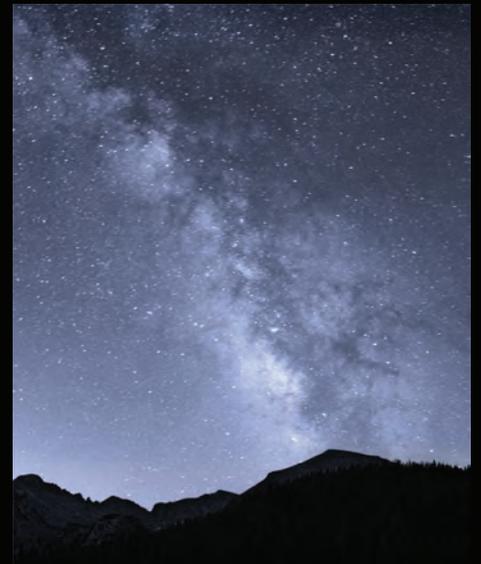
A-Mazing galaxy

Our solar system and all of the stars that we can see with our eyes are part of a spiral galaxy named the Milky Way. The Milky Way can only be seen when it is really dark. Have you ever seen the Milky Way? It got it's name because the ancient Greeks thought it looked like spilled milk flowing across the sky.

★ Can you find your way from the outer edge of the galaxy all the way to the giant black hole in its center?



An artist's idea of the Milky Way.



What we see from Earth.



Junior Ranger Night Explorer

As a Junior Ranger - Night Explorer, I promise to enjoy and protect the night sky by exploring my nighttime environment, not disturbing anything wild and remembering that light is a tool that I must use responsibly.

Junior Ranger Signature _____ Date _____

Park Ranger Signature _____ Date _____

EXPLORE • LEARN • PROTECT



To learn more about light pollution, visit www.darksky.org

To learn more about astronomy, visit www.starchild.gsfc.nasa.gov

To learn more about what is up at night, visit www.heavens-above.com

You can explore National Parks right from your own home!

Start earning your Webranger patch at www.nps.gov/webrangers

Learn more about how national parks are protecting dark skies at www.nature.nps.gov/air/lightscapes