Fight for the Stars: Be a Knight for the Night

Level 1 Activity Handout Packet

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Sky Heroes

An Activity Reinventing the Constellations

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Ancient cultures named the patterns of bright stars in the sky after their mythological heroes and monsters. Different countries and ethnic groups had completely different stories to tell about the same groups of stars. For example, the seven stars we call the Big Dipper were seen as a plow in England, as a stretcher with a sick patient by the Skidi Pawnee tribe of North America, and as seven Watchmen guarding the pole of the sky in Siberia. What if we could start over and rename the constellations (the star patterns) today? Who are the heroes we would now put in the sky?

This is an activity that serves several purposes:

- it teaches students that the constellation patterns and stories we now use are the products of particular cultures and times;
- it gets students thinking about how arbitrary these patterns and stories are;
- it helps students think through their own values about heroes;
- it allows students to talk with one another in small groups about a topic (whom they admire) they may not usually discuss;
- it helps them develop story telling and writing skills.

Procedure:

1. First do a lesson on the constellations, or hand out the backgrounder sheet at the end of this activity.
2. Divide students into groups of 3 - 5.
3. Tell them that they are astronomers assigned to help with a very important decision. The world of astronomers has decided that the old star patterns are no longer relevant and we have to start over again, naming the constellations. We want to name at least some of them after the greatest heroes of modern times. Their job is to come up with one hero on whom the whole group can agree.
4. Here are the ground rules: The hero they select must be a real person, not a fictional character. The person can be someone alive today, or someone from history. It can, for example, be a political leader, someone from the arts, a sports figure, a scientist, a doctor, or a visionary. The group must be able to explain why the person is their hero.
5. Once the group's hero has been selected, the next step is to find a way to put him or her in the sky. Hand out one of the blank star maps that accompany this activity and ask them to make a connect-the-dots star pattern that goes with their hero. Emphasize that the pattern doesn't have to *look like* the person. It could just be a symbol. So if they select Barry Bonds, the constellation could look like a bat and a ball. If they pick Beethoven, the constellation could resemble a piano or a set of notes. They should be prepared to share their pattern with the class and explain their reasoning.

Extension Activities

1. You can assign each student or group to research one of the actual 88 constellations and write a report on the legends associated with their star pattern. For a more advanced class, ask them to list some nice astronomical objects in their constellation and then observe them with the *Seeing in the Dark* Internet Telescope.

2. You can ask each student or group to write a report with more information on the hero they have selected and then present their findings to the class.

3. You can do a variant on the activity where groups now get to nominate a favorite hero from fiction (you need to decide if the hero has to be from a novel only, or if you will allow comic books, movies, or television shows to be part of the hero pool.)

4. Another possibility is to let students (especially younger ones) invent their own hero and to create a story to go with him or her. The story can be realistic or can be fantastic, like some of the ancient sky tales. Then they need to invent a nice star pattern that fits with the hero.

The thing to notice in all these activities is that it's often hard to agree. Once people come up with their favorite hero, they don't want to give it up for someone else's. The same was true for the constellation stories of the world's cultures. It was sometimes hard to give up the sky stories people grew up with and accept one uniform set of constellations for the whole world.

Resources for Further Exploration:

- Some favorite books for learning more about the sky stories of many different cultures include:

Ed Krupp's *Beyond the Blue Horizon: Myths and Legends of the Sun, Moon, Stars, and Planets.* 1991, Harper Collins.
Lloyd Motz and Carol Nathanson's *The Constellations.* 1988, Doubleday.
Julius Staal's *The New Patterns in the Sky: Myths and Legends of the Stars.* 1988, McDonald and Woodward.
Ray Williamson and Jean Monroe's *They Dance the Sky: Native American Star Myths.* 1987, Houghton Mifflin.

- Two good web sites for exploring constellation stories further are:

Windows to the Universe Mythology Page:
http://www.windows.ucar.edu/tour/link=/mythology/mythology.html&edu=mid&back=/search/search_navigation.html
The Constellations Web Site: http://www.dibonsmith.com/menu.htm

The Constellations
Background Information

On a completely clear night, if you could see the entire sky (with no trees, hills, or buildings in the way), you could see about 3000 stars. Even if you only see half as many, that's way too many dots of light to memorize. To cope with this great throng, human civilizations have long tried to identify groups of bright stars that made interesting connect-the-dots patterns.

Each civilization placed its own patterns in the sky, telling stories about the figures they had constructed that reflected their deepest hopes and fears. Many of the ancient star patterns were named after great heroes of legend or history, or after monsters that symbolized threats to human society (such as wild animals, storms, floods, or ice.) These star patterns were called *constellations*. Sometimes, there was a distinct smaller pattern within a constellation figure, such as the Big Dipper, which is part of the ancient constellation of the Big Bear. These smaller star groupings are now called *asterisms.*

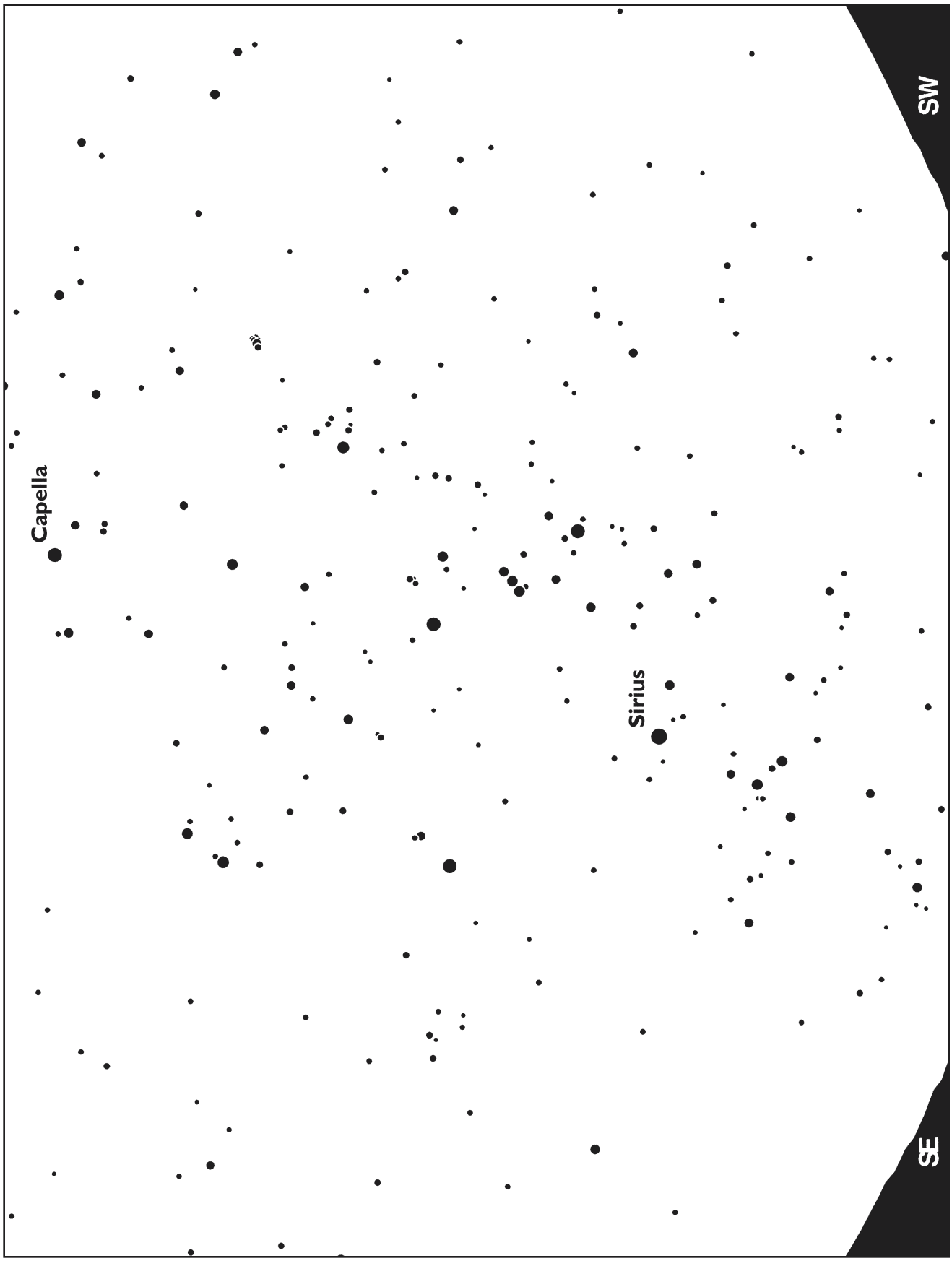
Dimmer stars that were not part of the constellation patterns were sometimes called "scattered" or "outside the image" stars. And which bright stars belonged to a constellation and which did not depended on whose constellations you adopted. The patterns and stories differed from continent to continent and culture to culture. And astronomers in the 18th and 19th century began making suggestions for additional constellations, many of which contradicted each other.

As long as astronomy was mostly a local pursuit, astronomers only needed to know the local system of identifying and naming the constellations. But by the beginning of the 20th century, as astronomy became more international, some system was needed to allow astronomers and astronomy enthusiasts around the world to understand each other's references to the sky. Astronomers from many countries formed the International Astronomical Union (IAU) to promote cooperation among the world's astronomers. In a series of discussions and resolutions between 1922 and 1930, the IAU defined a new standard system for mapping the sky.

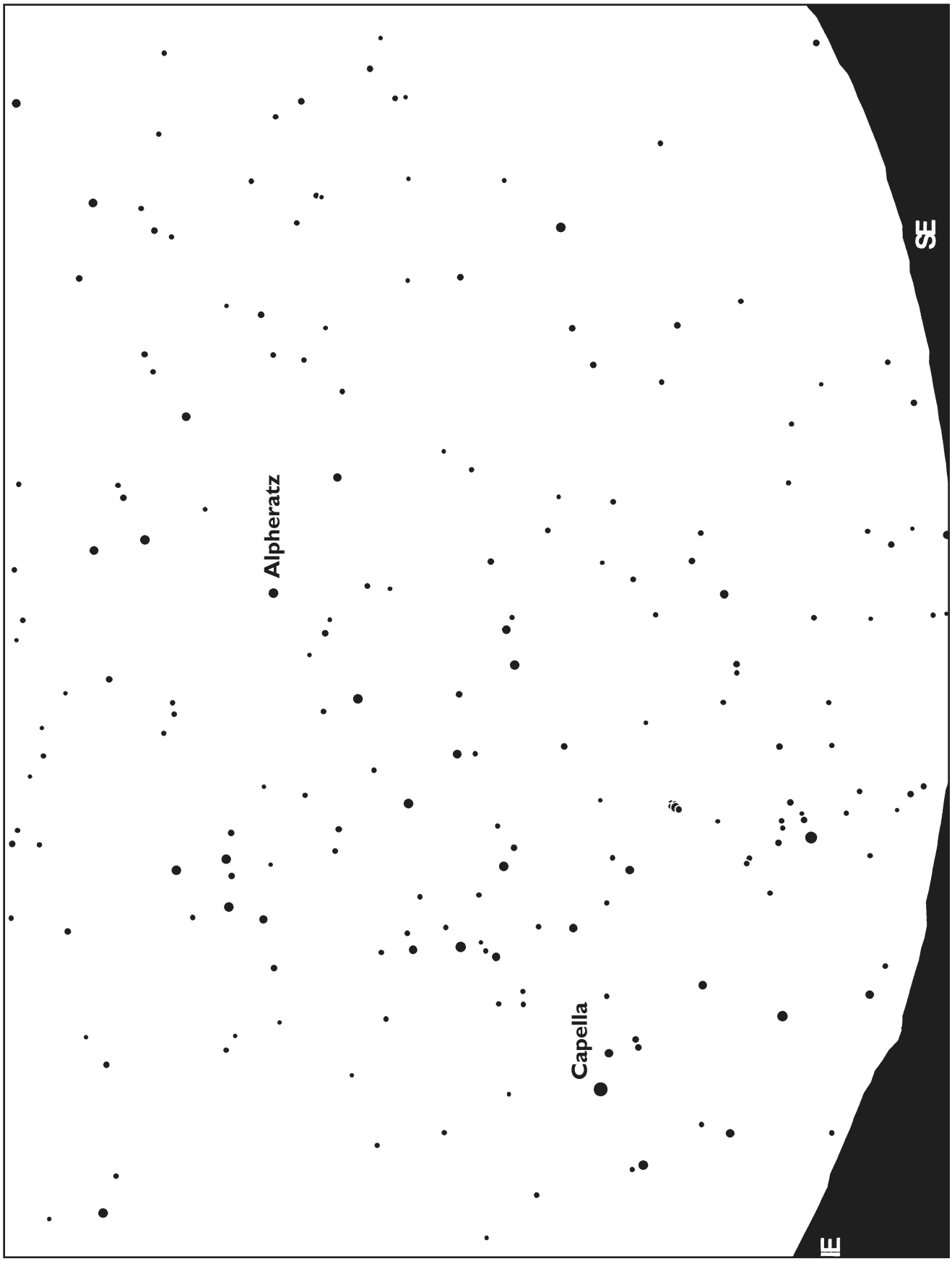
The IAU divided the sky into 88 boxes or sectors (much as the continental United States has been divided into 48 sectors called states) and called these boxes the constellations. Many of the sectors were named after a prominent ancient star pattern inside them. So the whole box with Orion the Hunter in it was now the constellation of Orion. It included not just the bright stars of the hunter's pattern, but all the stars in that box. For boxes that did not include a well-known ancient pattern, more recent suggestions were used, such as the constellations of Telescopium and Microscopium, in the Southern Hemisphere. (For more on the constellation names and how to pronounce them, see: http://www.skyandtelescope.com/howto/Constellation_Names.html)

Note that even some of the most famous star patterns don't resemble the people or creatures after whom they are named. But the state of Washington doesn't look like George Washington either! Constellations can symbolize a hero or monster as long as we agree on the symbol.

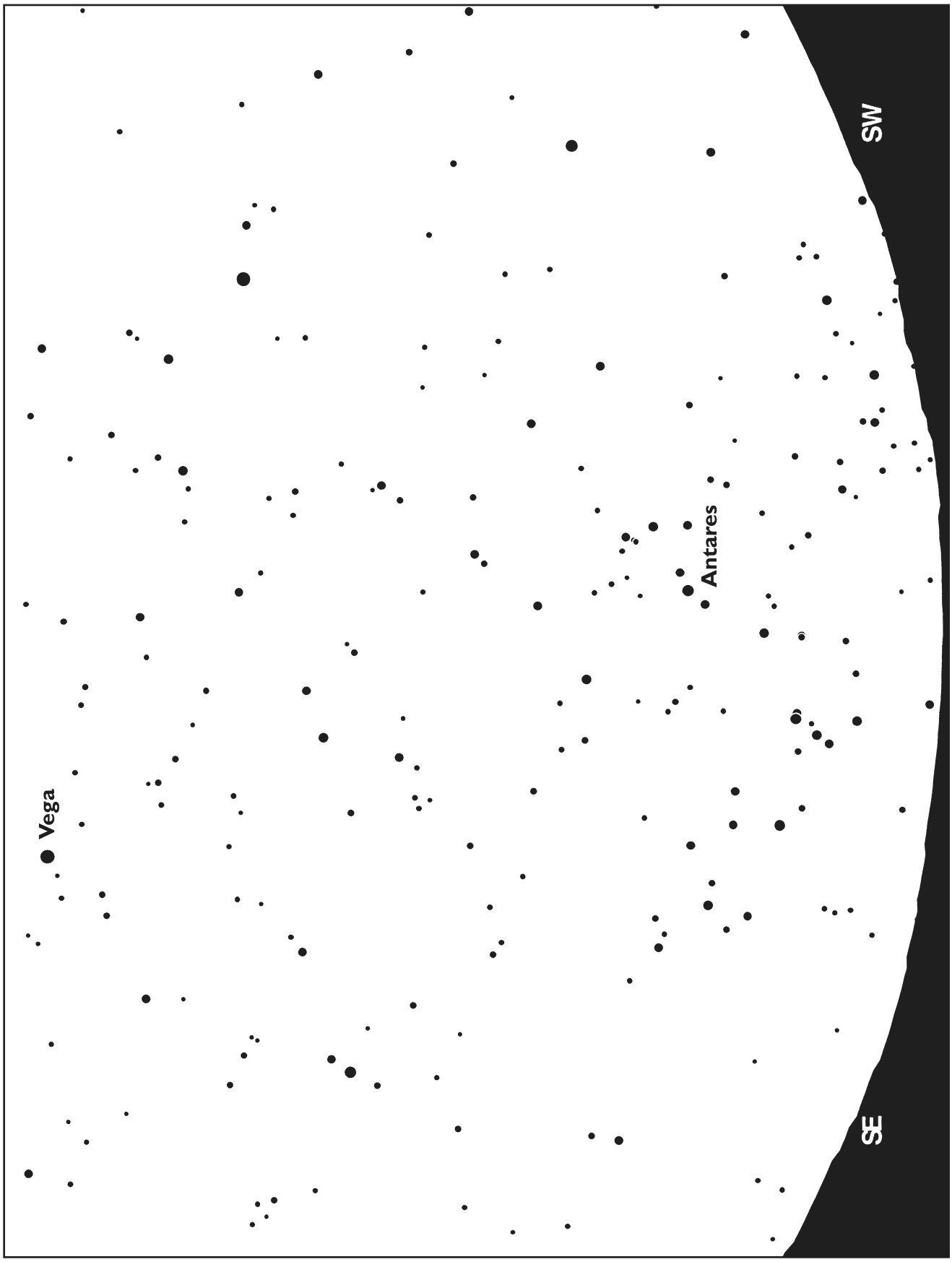
Winter Sky Heroes Star Chart



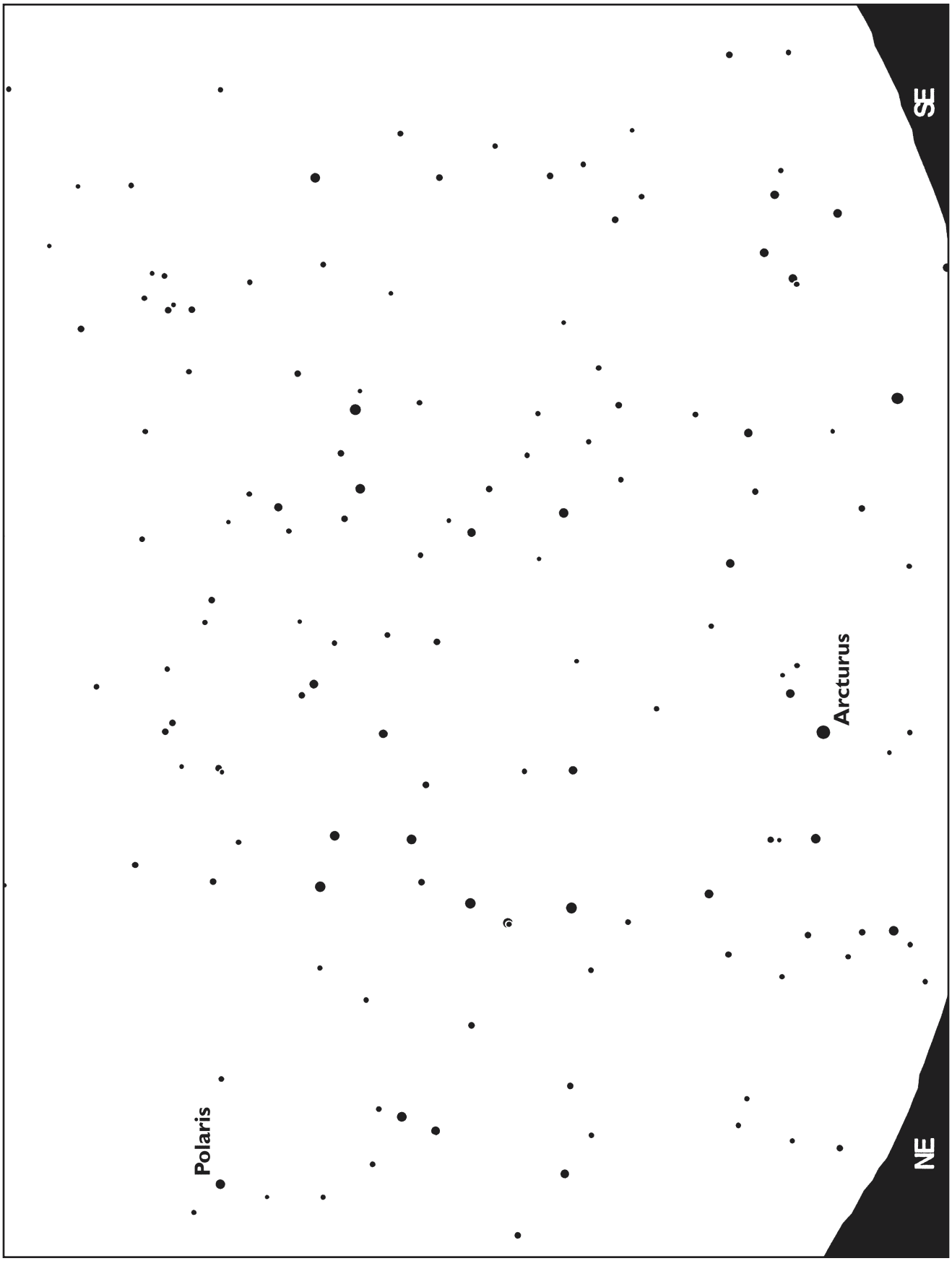
Autumn Sky Heroes Star Chart



Summer Sky Heroes Star Chart



Spring Sky Heroes Star Chart



Sunrise/Sunset Observation

Level 1, Lesson 1, Activity 2

Now that you have learned about constellations and the human connection with the night sky, you will get to go outside (or look out a window if you are unable to go outside) and experience the nighttime for yourself! For this activity, you should go outside just before sunrise or sunset with a responsible adult. You should turn off any artificial outdoor lighting that you have control of. While you are outside, think about and answer these questions:

1. Can you see any stars, the moon, or planets?

2. Does the sun rise/set or is the Earth moving?

3. Why do you think we call it rising/setting?

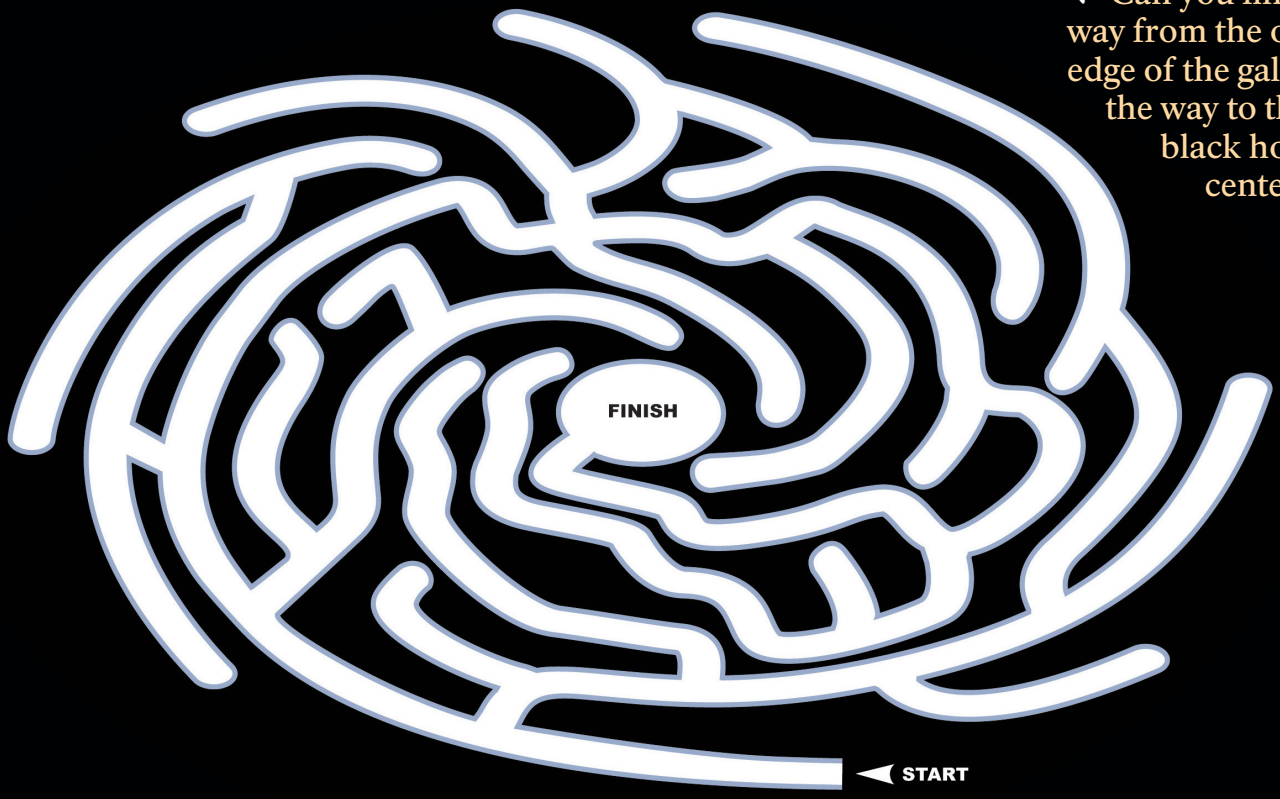
4. What do you notice about the sky before and after sunrise/sunset?

5. What is your favorite part about being outside and looking up at the sky?

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 its 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 seen from a great distance

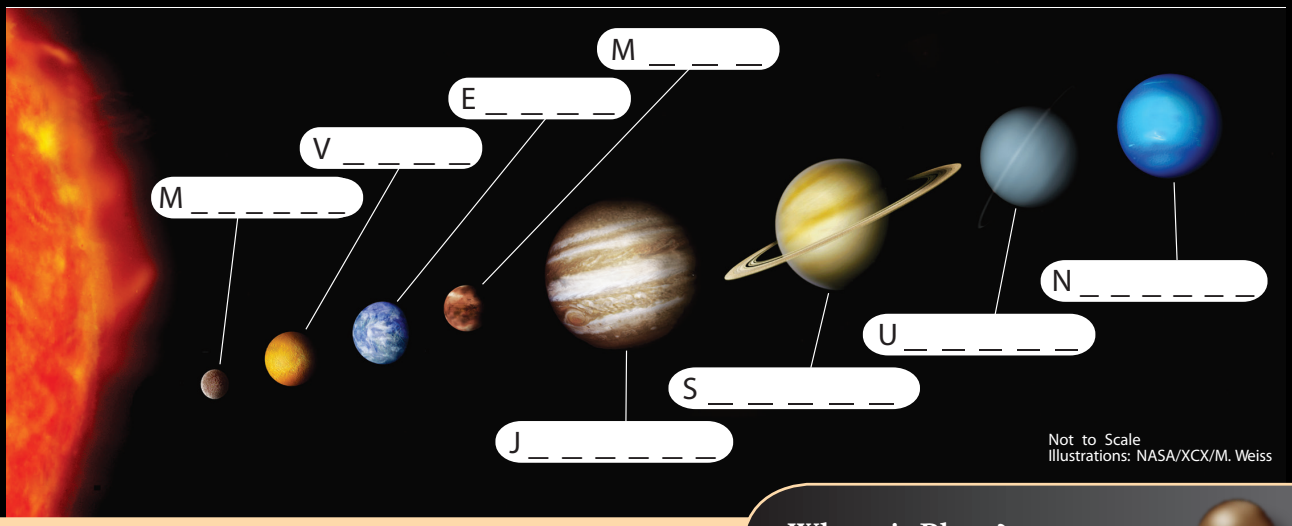
The Milky Way as seen from Earth.

Solar system smarts

★ This is a picture of our solar system. Label each planet to see its location from the sun.

Planets

Saturn
Uranus
Earth
Neptune
Venus
Jupiter
Mercury
Mars



★★ 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 pretending you are at the sun. Each set of steps you take brings you to another planet on this scale model of the solar system. Place a rock or other object in the location of each planet. This walk is a total of 369 steps. On this scale, the sun would be the size of an orange and the Earth the size of the period in this sentence.

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

Day & Night

Children talk about the differences between daytime and nighttime, including the activities they do at each time. Then they model the Earth's rotation with a globe and with their own bodies, to explore the reason for day and night. This activity works best in a workshop.

15–20 minutes

Workshop

Up to 15 children

Content Learning Goals

Children will begin to understand:

- We live on the planet Earth, which is a sphere.
- Daytime is when the Sun is in the sky and nighttime is when the Sun is not in the sky.
- The Earth is rotating (spinning), and this causes daytime, when our side of the Earth is facing the Sun, and nighttime, when our side of the Earth is facing away from the Sun.
- When it is daytime for us, it is nighttime on the other side of the Earth.

Materials

- Images of daytime and nighttime activities
- Images of the sky in the day and at night
- Globe or Earth ball
- Bear figures, two different colors
- Tape or other adhesive
- Bright light

Science Practices

Children will begin to engage in science practices around the phenomenon of day and night by:

- **Comparing** their observations of day and night to make a claim about how daytime is when the Sun is in the sky and nighttime is when the Sun is not in the sky.
- Using a **model** of the Sun and Earth (their own body) to explain why we see the Sun during the day and not the night.

SET-UP

- Set up in a location where children will have plenty of room to move around and where you can switch off the lights.
- Check that you can use the light to illuminate one side of the Earth ball such that all of the children will be able to see each side of the Earth, the light and the dark.
- Stick tape or other adhesive on the bottoms of the two bears so that you can stick them onto the Earth ball.

ACTIVITY DESCRIPTION

1. Invite children to discuss their ideas about the activities they engage in during the day and help them connect these experiences to the Sun:

- When you play outside in the daytime, is it dark or is it light?
- Do you need a flashlight to see?
- Where does the light come from in the daytime?
- What are some other things you do in the daytime when it is light outside? (eat, play, do chores, shop, school, watch television, etc.).

2. Ask children about their experiences with the nighttime:

- What do you see in the sky at night?
- When do you see the stars in the sky?
- When you go to sleep, and then wake up while it's still nighttime, do you see the Sun?
- What are some things you do in the evening when it's dark outside? (If they turn a light on inside, they can eat, read, watch television, take baths, etc. You must emphasize that they have to turn a light on; the Sun doesn't make light in their house at night. They sleep when the Sun and all other lights are off.)

3. Show some photographs of daytime and nighttime skies:

- Ask the children, *What do you notice in this photo? Is it day or night? How can you tell?* They may point to the Sun in the sky for the day. But some children see the Moon in the daytime sky and think this means it is nighttime.
- Ask the children, *What is different about the daytime sky compared to the nighttime sky?* or *What can we only see in the daytime sky and not at night?* They might say other things, such as the sky is blue during the day or that we see stars at night, but all of this still comes back to whether the Sun is in the sky or not. This conversation allows you to help the children to summarize their observations as a claim about the major difference between day and night skies: the presence or absence of the Sun.

4. Use a physical Earth ball to model how rotation explains day and night:

- Let's make some models to help explain why we only see the Sun during the daytime and not during the nighttime.
- Here is a bigger model of the Earth (show Earth ball or globe). Red Bear lives on Earth, in the same place that we live. (Ask children if anyone can point to where we live. Place the bear on that spot with some tape or other adhesive.)
- Blue Bear lives on the other side of the Earth, over here in China. (Place the Bear on the spot.)
- We'll turn off the lights and use this bright light as the Sun. See how the Sun is shining on one side of the Earth? Red Bear is on that side of the Earth so it's daytime for her right now. She sees the Sun when she looks up in the sky, and it is daytime for her. She's eaten her breakfast and went outside to play. She went to swimming lessons and all the things she does in the daytime.
- Blue Bear is on the dark side of the Earth. Can Blue Bear see the Sun right now? (No, the Earth is in the way.) He doesn't see the Sun in the sky and it is dark outside. It's nighttime in China where Blue Bear lives. Blue is sound asleep. It's nighttime and everyone in his family is sleeping in their beds.
- Is it always light here where Red Bear lives? Is it always dark in China where Blue Bear lives?
- Watch what happens as the Earth rotates (spins). Slowly rotate the globe in a counter-clockwise direction:
  - Even though we don't feel it, the Earth is actually always moving. Here Red Bear is now having dinner, maybe having a bath, getting ready for bed. (Keep rotating the globe.)
  - Blue Bear is now waking up and brushing his teeth and eating breakfast, getting dressed.
  - Red Bear is now tucked into bed.
  - Blue Bear is playing outside in the park, walking his dog, and going swimming.
  - By the time Red wakes up, and Blue goes to sleep again, one day (24 hours) has passed.

5. Use children's bodies as a model of the Earth as they explain day and night:

- Now we can all pretend that we are the Earth. Imagine we live on the tip of our noses, Mt. Nose! Can you face the Sun (lamp) so that it's daytime on Mt. Nose? Now slowly rotate so that is nighttime on Mt. Nose, facing away from the Sun.
- Rotate together as you sing this song:

Day/Night Song

To the tune of "Are You Sleeping / Frère Jacques"

The sun is shining, the sun is shining. (Face the lamp.)
It is day, it is day.
The sun is gone and now it's night. (Rotate so backs are facing lamp.)
We can't see without a light.
CHORUS
Day and night, (Rotate twice.)
Day and night.

- **Hold up some pictures of different activities, both daytime and nighttime.** Ask the children: *Does this picture show daytime or nighttime?* Next, ask the children which way they should be facing for the time shown in the picture: *Great, it is daytime? Can you show me where the Earth would be facing during daytime?* The children will rotate their bodies so that their noses face the light for daytime or face away from the light for nighttime as appropriate for the activity in the pictures.

  This is an important opportunity for children to actively engage in applying what they learned about the Earth's rotation to explaining why we see the Sun during the day and not the night.

- **Wrap up:** So, the Sun is in the sky in the bright daytime, and not in the sky in the dark nighttime, because the Earth is moving. That's why we have daytime and nighttime.

BACKGROUND INFORMATION

The following information about learning science and astronomy is intended for the educator who will facilitate the "Day & Night" activity. The activity is a developmentally appropriate first step toward the children eventually understanding the concepts explained below, perhaps years later. We do not intend the educator to cover most of these concepts with the children during the activity. This information is provided to give the educator a good basic understanding of the scientific concepts that the activity is moving toward and the way that many children think about these topics, and preparation to answer questions from very curious children or adults.

LEARNING SCIENCES

Shape of the Sun and Earth

Young children often do not conceptualize the Sun and Earth as spheres. Research across many cultural contexts have found that preschool-age and early elementary-age children in countries including China, France, New Zealand, and the United States hold a range of ideas about the Earth's shape including that it is flat, a hollow sphere, or that there is a separate Earth in the sky (dual earth model).[1,2,3] Valanides and colleagues investigated 5- and 6-year-old-children's ideas about the shape of the Sun and Earth.[2] They found that, prior to instruction, more children suggested that the Sun is a sphere (73%) than believed the Earth to be a sphere (55%). Only about half of the children thought that both were spheres based on their selection of a sphere shape over other possible shapes for these two objects.

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[1] Blown, E. J., & Bryce, T. G. K. (2006). Knowledge restructuring in the development of children's cosmologies. *International Journal of Science Education*, *28*(12), 1411–1462.

[2] Valanides, N., Gritsi, F., Kampeza, M., & Ravanis, K. (2000). Changing pre-school children's conceptions of the day/night cycle Changer les Conceptions d'Enfants d'Age Prescolaire sur le Phenomene du Cercle'Jour-Nuit'Cambiar las Concepciones de los Ninos Preescolares en el Ciclo Dia/Noche. *International Journal of Early Years Education*, *8*(1), 27–39.

[3] Vosniadou, S., & Brewer, W. F. (1992). Mental models of the earth: A study of conceptual change in childhood. *Cognitive psychology, 24*(4), 535–585.

However, after participating in 30 minutes of instruction on how the Earth's rotation causes day and night, using a globe and a light source, 88% selected a sphere to represent the Earth, 91% selected a sphere to represent the Sun, and 82% selected a sphere for the shape of both objects. Kallery also found positive results with instruction on the shape of the Sun and Earth with 4- to 6-year-old children; after instruction, 92.3% of the children make sphere shaped model of the Sun and Earth with playdough.[4]

Explaining Day and Night with the Earth's Rotation

Preschool-age children often associate the reason why we have day and night with the movement of the Sun, believing that it is actually moving up and down or from place to place.[2,4] In a study of 5- and 6-year-old children, the majority were reluctant to offer any explanation for the day/night cycle.[2] A few gave religious or mythological explanations. Almost a third of the children explained in terms of the Sun's motion. Only 2 out of 33 children used the Earth's movement and one of those used the Earth's rotation.

There is evidence that preschool children are capable, with experience and support, of shifting closer to using the Earth's rotation to explain day and night. In one 30-minute instructional intervention with 5- and 6-year-olds, the majority (63%) attributed day/night to the movement of the Earth though only four of these were using just the Earth's rotation.[2] The children were more likely to use a combination of the Earth's rotation and its motion about the Sun than the Earth's rotation alone. In a study of 4- to 6-year-olds involving a longer period of instruction (multiple days within a preschool), 86.8% of the children used the Earth's rotation to account for the change in day/night.[4]

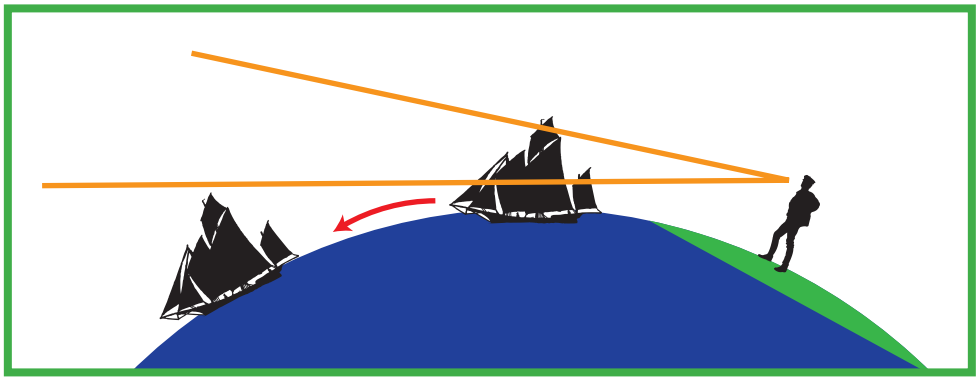
Some research has found that even older elementary students may not be aware of the Earth's rotation;[5] however, just knowing that the Earth rotates is not enough for students to use this concept to explain day and night. *My Sky Tonight* researcher Dr. Julia Plummer and her colleagues found that most of the third grade students they interviewed knew that the Earth rotates.[6] However, fewer than half used the Earth's rotation to explain why the Sun appears to move to cause day and night. This suggests that children need support in connecting what the Earth is doing in space (rotating) to what we see happening to change day and night.

ASTRONOMICAL SCIENCE

What shape is the Earth?

In our day/night model we use a round ball for the Earth, but have to admit that the roundness of the Earth is not an easy thing to observe while walking around on its surface. The only people who have directly observed that the Earth is spherical are astronauts who have traveled far enough off the surface to get this unique perspective. But long before the space program, the ancient Greeks did know that the Earth is round through other evidence. Consider:

1. Watch a ship with tall masts sail away. As all things do, it appears to get smaller, but the bottom of the ship will disappear first. Eventually, the mast will, too. What, except the curve of the Earth could explain that?



[4] Kallery, M. (2011). Astronomical concepts and events awareness for young children. *International Journal of Science Education, 33*(3), 341–369.

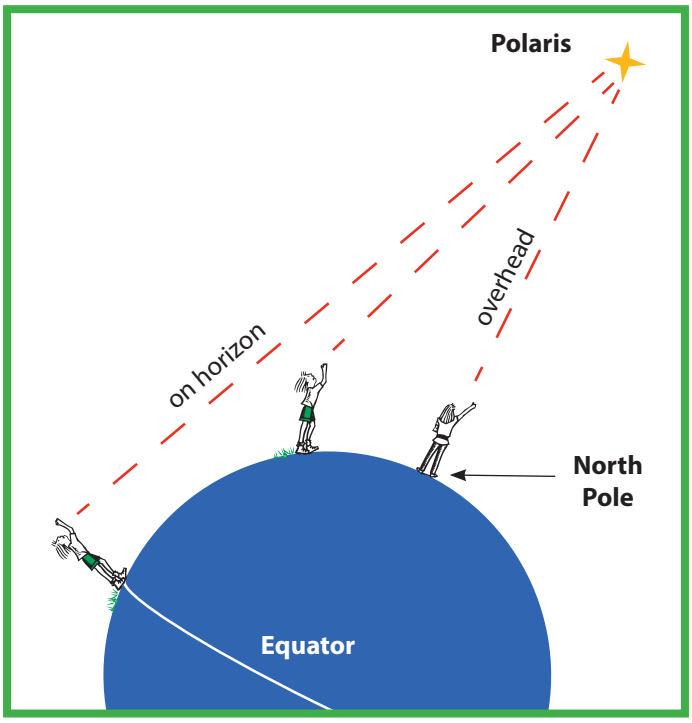
[5] Sharp, J. G. (1996). Children's astronomical beliefs: a preliminary study of Year 6 children in south-west England. *International Journal of Science Education, 18*(6), 685–712.

[6] Plummer, J. D., Kocareli, A., & Slagle, C. (2014). Learning to explain astronomy across moving frames of reference: Exploring the role of classroom and planetarium-based instructional contexts. *International Journal of Science Education, 36*(7), 1083–1106.

2. Watch a lunar eclipse. As the Moon enters the Earth's shadow, the shape of the edge of the shadow is always an arc of a circle. This image shows the shape of the Earth's shadow as the Moon moves from right to left through it.

The only shape that would consistently cast a circular shadow is a spherical object. If the Earth were round, but flat like a plate or disk, there would be angles where eclipse shadows are ellipses, not circles. Try it!

3. As you move north on the surface of the Earth, the position of the North Star is higher in the sky.



Earth's Rotation

The Earth rotates continuously in a counter-clockwise direction. The most direct evidence of the rotation of the Earth is the rising and setting of the Sun, Moon, and stars each day and night. You might wonder why there isn't a strong wind, like you experience when moving in a fast car, but in fact the atmosphere is rotating with the solid earth, so the wind that we feel is from local air pressure differences rather than from the overall rotation of the Earth.

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Senses Observation

Level 1, Lesson 3, Activity

It's important for us to know how important the dark is to our health. Not only does the dark help us sleep, but it also protects us from illnesses and other unhealthy habits. For this activity, you should go outside once it is dark with a responsible adult. You should turn off any artificial outdoor lighting that you have control of.

Once outdoors, you should focus on the senses, preparing to answer the following questions in writing when you come back in. When you first go outside, you should sit outside to let your eyes adjust to the dark. It usually takes around ten minutes. Once your eyes have adjusted to the dark, think through your senses: sight, hearing, touch, smell, taste. When you go back inside, answer the following questions:

- Seeing: Can you see the moon and the stars?

- Seeing: What is the brightest thing you see?

- Hearing: Close your eyes and listen. What do you hear?

- Smelling: What can you smell?

- Touching: What can you feel using your sense of touch? Is there any wind?

- Touching: Does the air feel different at night than during the day?

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

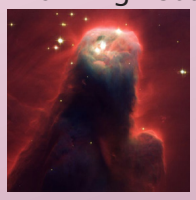
Deep-sky match

Draw a line from each picture to its description.

Globular cluster

Asteroid

Star-forming nebula



Galaxy cluster

Many galaxies living in the same neighborhood

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

Group of tightly packed old, yellow stars

Two stars that orbit each other

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

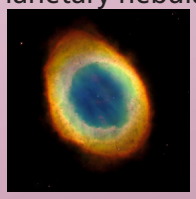
Thick cloud of gas from which new stars can form

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

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

Spiral galaxy

Planetary nebula



Comet

Binary star system

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!

★ Three objects
★★ A line of three objects
★★★ Two lines of three objects

Smart stargazing

Stargazing is great, but it is always more fun when you are prepared!

- Wear **warm clothes**. It can get cold and windy at night.
- Bring **water**, a **snack**, and a **chair** to sit on.
- Use a **red flashlight** to move around at night. (White light will spoil your **night vision**.)
- Bring a **star chart** or planisphere to find the constellations.
- Use **binoculars** to look at planets and star clusters.
- Try not to bump stargazers' **telescopes** or touch the eyepieces.
- Most importantly, bring lots of time and **curiosity**!

M	A	N	C	H	A	I	R	Y	V	I	S	B
N	I	G	H	T	V	I	S	I	O	N	I	I
T	O	R	S	T	S	N	A	C	K	R	H	N
T	I	W	N	K	T	T	H	E	P	E	A	O
E	R	A	K	E	A	X	P	E	R	D	I	C
L	E	R	N	C	R	E	E	N	D	F	S	U
E	A	M	F	T	C	E	R	T	H	L	E	L
S	S	C	U	N	H	G	O	E	S	A	D	A
C	O	L	W	N	A	B	U	T	T	S	H	R
O	E	O	R	E	R	I	S	J	U	H	S	S
P	T	T	W	A	T	E	R	A	S	L	M	U
E	C	H	H	C	U	R	I	O	S	I	T	Y
S	T	E	O	S	E	E	I	N	T	G	H	E
P	A	S	R	K	A	F	T	E	R	H	D	A
G	N	I	Z	A	G	R	A	T	S	T	R	K

Word search

★ Find five of the orange words in the word search puzzle. (Hint: Look for vertical, horizontal, and even backwards words.)

★★ Find all of the the orange words in the word search.

★★★ Find all of the the orange words in the word search.Then look at the letters in the word search table that are *not* circled. Starting with the first letter, write each leftover letter on the blanks below to discover the hidden message. (Some of the letters are already written for you.)

M _ _ _ v _ _ _ _ _ _ _ _ _ _ _ _ _ t _ _ _

_ _ _ _ e _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

a _ _ _ _ _ _ _ _ _ S _ _ _ _ _ _ _ _ _ _ ,

_ _ _ t _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

_ _ _ _ t _ _ _ _ _ _ _ _ _ _ _ p _ _ _ _

_ _ _ _ _ _ _ _ _ _ _ _ _ !

Kirtland's Warbler

Setophaga kirtlandii

The first Kirtland's warbler in North America was identified in 1851 from a specimen collected on Dr. Jared Kirtland's farm near Cleveland, Ohio. Biologists did not learn where it nested until 1903 when they found a warbler nest in northern lower Michigan. Today, Kirtland's warblers face two significant threats: lack of crucial young jack pine (*Pinus banksiana*) forest habitat and the parasitic brown-headed cowbird (*Molothrus ater*).

A pair of Kirtland's warblers requires at least eight acres of dense young jack pine forest to nest, but often 30 to 40 acres is needed to raise their young. Their exacting requirements for nesting, as well as cowbird parasitism, caused a drastic decline in numbers and led the U.S. Fish and Wildlife Service to list the Kirtland's warbler as an endangered species in 1967.

Endangered means a species is in danger of extinction throughout all or a portion of its range, while the less dire *threatened* designation means a species is likely to become endangered within the foreseeable future.

Until 1995 Kirtland's warblers had only been known to nest in the northern part of Michigan's Lower Peninsula. Today, they also nest in the Upper Peninsula, and since 2007, have nested in Wisconsin and Canada. They migrate from their nesting grounds to the southeastern coast of the United States on their way to wintering grounds in the Bahamas.

Kirtland's warblers have bluish-gray backs with black streaks, yellow breasts, black side streaks and split white eye rings. They measure about six inches in length. Females are not as brightly colored as males.

Primarily insect eaters, Kirtland's warblers forage for insects and larvae near the ground and in lower parts of pines and oaks. They also eat blueberries.

Photo by USFWS; Joel Trick

Forest fires, once thought to harm the environment, are crucial to the survival of the Kirtland's warbler. Without fire, jack pine cones do not completely release their seeds and the natural establishment of new jack pine stands is prevented.

Kirtland's warblers nest only on the ground near the lower branches and in large stands of young jack pines that are 5 to 20 feet tall and 6 to 22 years old. The tree's age is crucial, although biologists are not sure why. It is possible that the birds need low branches near the ground to help conceal their nests. Before the trees are six years old, the lower branches are not large enough to hide the nest. After 15 years, these lower branches begin to die.

Concealed by branches, overhanging grass and low shrubs, the warbler's cup-shaped nest is made of grasses. While being fed by their mates, females incubate four to five eggs for about 14 days. After hatching, the chicks remain in the nest for another nine or ten days before *fledging*, or leaving the nest.

Once it was believed that forest fires harmed the environment. However, we now know that fires play an important role in forest ecosystems. For example, without fire, jack pine cones do not completely release their seeds. Suppressing forest fires prevented the natural establishment of new jack pine stands. Since Kirtland's warblers will only nest in stands of young jack pines, the population dwindled dramatically before scientists realized that there is a role for fire in forest ecology — and in the Kirtland's warbler life history.

The second greatest threat to Kirtland's warbler survival is the brown-headed cowbird. Cowbirds lay eggs in other bird's nests, leaving the unsuspecting *hosts* to incubate and care for the young cowbirds. This is called nest parasitism.
When a female cowbird lays its egg in a nest, it often removes one of the host's eggs. The cowbird egg hatches a day before the others, getting a head start on growth. The young

Photo by Ron Austing

Kirtland's warbler populations have rebounded thanks to protection under the Endangered Species Act and conservation measures by the U.S. Fish and Wildlife Service, U.S. Forest Service and the Michigan Department of Natural Resources and Environment. Biologists counted 1,773 singing male Kirtland's warblers in 2010.

cowbird is bigger and able to claim more food than other nestlings, and may crowd or push the other baby birds out of the nest.

Some species have developed ways to combat cowbird nest parasitism. They may abandon their nest and lay eggs elsewhere or build another nest on top of the cowbird egg. However, Kirtland's warblers have not developed such defenses. Because of cowbird nest parasitism and Kirtland's warblers' inability to protect their nest and young, less than a third of their nests produced young in 1971.

The U.S. Fish and Wildlife Service, in cooperation with the Michigan Department of Natural Resources, the U.S. Forest Service and the Michigan Audubon Society, initiated an aggressive cowbird removal program in 1972 that has continued to this day. As a result, Kirtland's warblers now have very good nesting success and enough young are being produced to increase the population.

Biologists, naturalists, and bird watchers began to recognize the dire plight of the Kirtland's warbler in the 1950s. To keep track of the dwindling numbers of Kirtland's warblers, birders counted the number of singing males every 10 years starting in 1951. Females do not sing and therefore are almost impossible to count accurately, but studies indicate there is approximately one female for each male. In 1961, the total population of males and females was more than 1,000. By 1971 the population had plummeted to about 400 birds. At that time, biologists began counting singing male warblers every year.

In 1973, the U.S. Fish and Wildlife Service (Service) appointed the Kirtland's Warbler Recovery Team, the first endangered species recovery team established by the Service. This team included representatives from the Michigan Department of Natural Resources, the Service, U.S. Geological Survey, U.S. Forest Service and interested citizens. The team's job was to determine how to save the warbler from extinction. They identified and prioritized conservation actions.

Today, warbler conservation measures are working. About 190,000 acres of public lands have been set aside by the Michigan Department of Natural Resources, the U.S. Forest Service and the Service specifically for Kirtland's warbler management. From record lows of 167 in 1974 and 1987, the number of singing males increased to a record high of 1,828 in 2011.

The recovery team has recommended that 38,000 acres of warbler nesting habitat always be available—enough to reach the recovery goal. Since the trees continuously grow older and warblers cannot nest in forests older than about 22 years, land managers must create new habitat every year. About four thousand acres of forest are clearcut and 2-year-old jack pine seedlings planted each year. The cut trees are chopped and used for fuel or particle board —nothing is wasted. Over ninety-five percent of the warblers counted during recent censuses were on these managed land areas.

A portion of the Michigan Department of Natural Resources annual habitat management is funded through State Wildlife Grant money from the U.S. Fish and Wildlife Service. In recent years, the amount of these grants has decreased, along with other funding for similar work by the U.S. Forest Service and the State of Michigan.

Due to many dedicated people, the Kirtland's warbler has met the recovery population goal. However, as a conservation-reliant species, the continued success of Kirtland's warbler is dependent on annual habitat management and cowbird control. It is hoped that soon, provisions can be made to ensure that these management activities are continued into the future, allowing Kirtland's warblers to be removed from the list of threatened and endangered species. Once these commitments are in place, we can be assured that Kirtland's warbler will continue to search out young jack pine forests each spring for generations to come.

U.S. Fish & Wildlife Service
http://www.fws.gov/midwest/endangered

Revised January 2012

Light Pollution and Animals

The Migration Game Instructions

You are a Kirtland's warbler migrating north 2,200 kilometers from Caribbean Sea islands in the Bahamas (like Little Abaco, Eleuthera, San Salvador and Andros). You are traveling to the nesting grounds in the northern parts of the lower peninsula of Michigan, USA (between Lake Michigan and Lake Huron). After successfully hatching your chicks, you will travel another 2,200 kilometers back again to the Bahamas. At the start of your journey, you fly north mostly during the nighttime in May to avoid predators and on your return, you fly south during the nighttime in October.

1. Each player should have a game piece represented by a button.
2. To begin, place the pieces on the "Start" box.
3. On your turn, roll the dice and move that many spaces up the blue path. If you land on a space that says "Draw a Migration Card", draw a card from the deck with the male Kirtland's Warbler (above) on the back and follow its instructions.
4. When you get to the nesting grounds (no matter what number is rolled), draw a card from the "Nesting Card" deck (showing the female Kirtland's Warbler the with her offspring). Read the card out loud. Follow instructions, if any.
5. You must wait your turn; then draw another nesting card and read the card out loud. Repeat this step two more times.
6. After drawing at least 4 cards while in the nesting grounds, roll the dice & move your game piece down the green path (toward the finish line), taking turns after each move.
7. The objective is to be the first bird back to the Bahamas and, hence, the least affected by light pollution. You have completed your journey when you land or have passed "Finish" box, no matter what number on the dice is rolled.

You've flown through a city. Luckily, you fly right through! Roll again.	You've flown through a city. Luckily, you fly right through! Roll again.
You've flown through a city. Unfortunately, you hit a building. Skip a turn to recover.	You've flown through a city. Unfortunately, you hit a building. Skip a turn to recover.
You've flown through a city. Unfortunately, you hit a building and do not survive. Go back to start.	You've flown through a city. Unfortunately, you hit a building and do not survive. Go back to start.
You've flown through a city. Luckily, you fly right through!	You've flown through a city. Luckily, you fly right through!
You've flown through a city. Luckily, you fly right through!	You've flown through a city. Luckily, you fly right through!
You've flown through a city. Unfortunately, you get confused by the lights and start circling around a building. Skip a turn.	You've flown through a city. Unfortunately, you get confused by the lights and start circling around a building. Skip a turn.


Migration Card
Joel Trick, USFWS

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Joel Trick, USFWS

Migration Card
Joel Trick, USFWS

You've flown through a city. You are confused by the lights and start singing in the middle of the night. Skip a turn.	You've flown through a city. You are confused by the lights and start singing in the middle of the night. Skip a turn.
You've flown through a city. Unfortunately, you hit a building. Skip a turn to recover.	You've flown through a city. Unfortunately, you hit a building. Skip a turn to recover.
You've flown through a city. Luckily, you fly right through!	You've flown through a city. Unfortunately, you get confused by the lights and start circling around a building. Skip a turn.
You've flown through a city. Luckily, you fly right through!	You've flown through a city. Luckily, you fly right through!
You've flown through a city. Luckily, you fly right through!	You've flown through a city. Luckily, you fly right through! Roll again.
You've flown through a city. Unfortunately, you get confused by the lights and start circling around a building. Skip a turn.	You've flown through a city. Unfortunately, you get confused by the lights and start circling around a building. Skip a turn.


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Migration Card
Joel Trick, USFWS

You stop to rest but city lights cause you to turn back to find sufficient ground cover from short shrubs. Go back 2 steps.	You stop to rest but city lights cause you to turn back to find sufficient ground cover from short shrubs. Go back 2 steps.
You stop to rest but city lights cause you to turn back to find sufficient ground cover from short shrubs. Go back 2 steps.	You stop to rest but city lights cause you to turn back to find sufficient ground cover from short shrubs. Go back 2 steps.
You stop to rest but city lights cause you to turn back to find sufficient ground cover from long grass. Go back 3 steps.	You stop to rest but city lights cause you to turn back to find sufficient ground cover from long grass. Go back 3 steps.
You stop to rest but city lights cause you to turn back to find sufficient ground cover from long grass. Go back 3 steps.	You stop to rest but city lights cause you to turn back to find sufficient ground cover from long grass. Go back 3 steps.
You stop to rest but city lights cause you to turn back to find sufficient ground cover from low branches. Go back a step.	You stop to rest but city lights cause you to turn back to find sufficient ground cover from low branches. Go back a step.
You stop to rest but city lights cause you to turn back to find sufficient ground cover from low branches. Go back a step.	You stop to rest but city lights cause you to turn back to find sufficient ground cover from low branches. Go back a step.


Migration Card
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Migration Card
Joel Trick, USFWS

A cowbird lays an egg in your nest and displaces one of your 5 eggs. The cowbird egg hatches a day early & claims more food. You must wait an extra turn in the nesting area.	A cowbird lays an egg in your nest and displaces one of your 5 eggs. The cowbird egg hatches a day early & claims more food. You must wait an extra turn in the nesting area.
A cowbird lays an egg in your nest and displaces one of your 5 eggs. The cowbird egg hatches a day early & claims more food. You must wait an extra turn in the nesting area.	You could not find a forest of Jack Pines (6-22 years old) with enough low-lying brush to hide your nest. You must wait an extra turn in the nesting area.
You lay your eggs too close to a city. Your eggs hatch earlier than the others because of the light.	You could not find a forest of Jack Pines (6-22 years old) with enough low-lying brush to hide your nest. You must wait an extra turn in the nesting area.
You lay your eggs too close to a city. Your eggs hatch earlier than the others because of the light.	You lay your eggs too close to a city. Your eggs hatch earlier than the others because of the light.
After eggs hatch, stay with your chicks for ten days before they leave the nest.	After eggs hatch, stay with your chicks for ten days before they leave the nest.
After eggs hatch, stay with your chicks for ten days before they leave the nest.	After eggs hatch, stay with your chicks for ten days before they leave the nest.


Nesting
Card
Ron Austing, USFWS


Nesting
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Ron Austing, USFWS


Nesting
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Ron Austing, USFWS


Nesting
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Ron Austing, USFWS


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Nesting
Card
Ron Austing, USFWS

Hard to find 30 acres of young, dense Jack Pine forest to raise your chicks with so many city lights.	Hard to find 30 acres of young, dense Jack Pine forest to raise your chicks with so many city lights.
Hard to find 30 acres of young, dense Jack Pine forest to raise your chicks with so many city lights.	You could not find a forest of Jack Pines (6-22 years old) with enough low-lying brush to hide your nest. You must wait an extra turn in the nesting area.
Too many city lights. Hard to find 8 acres of young Jack Pine forest to nest.	Too many city lights. Hard to find 8 acres of young Jack Pine forest to nest.
Too many city lights. Hard to find 8 acres of young Jack Pine forest to nest.	This is a “Get out of the Nesting Grounds” free card. On your next turn, roll the dice to move.
You’ve found good nesting grounds away from lights. Eggs are “incubated” for 14 days.	You’ve found good nesting grounds away from lights. Eggs are “incubated” for 14 days.
You’ve found good nesting grounds away from lights. Eggs are “incubated” for 14 days.	You’ve found good nesting grounds away from lights. Eggs are “incubated” for 14 days.


Nesting Card
Ron Austing, USFWS

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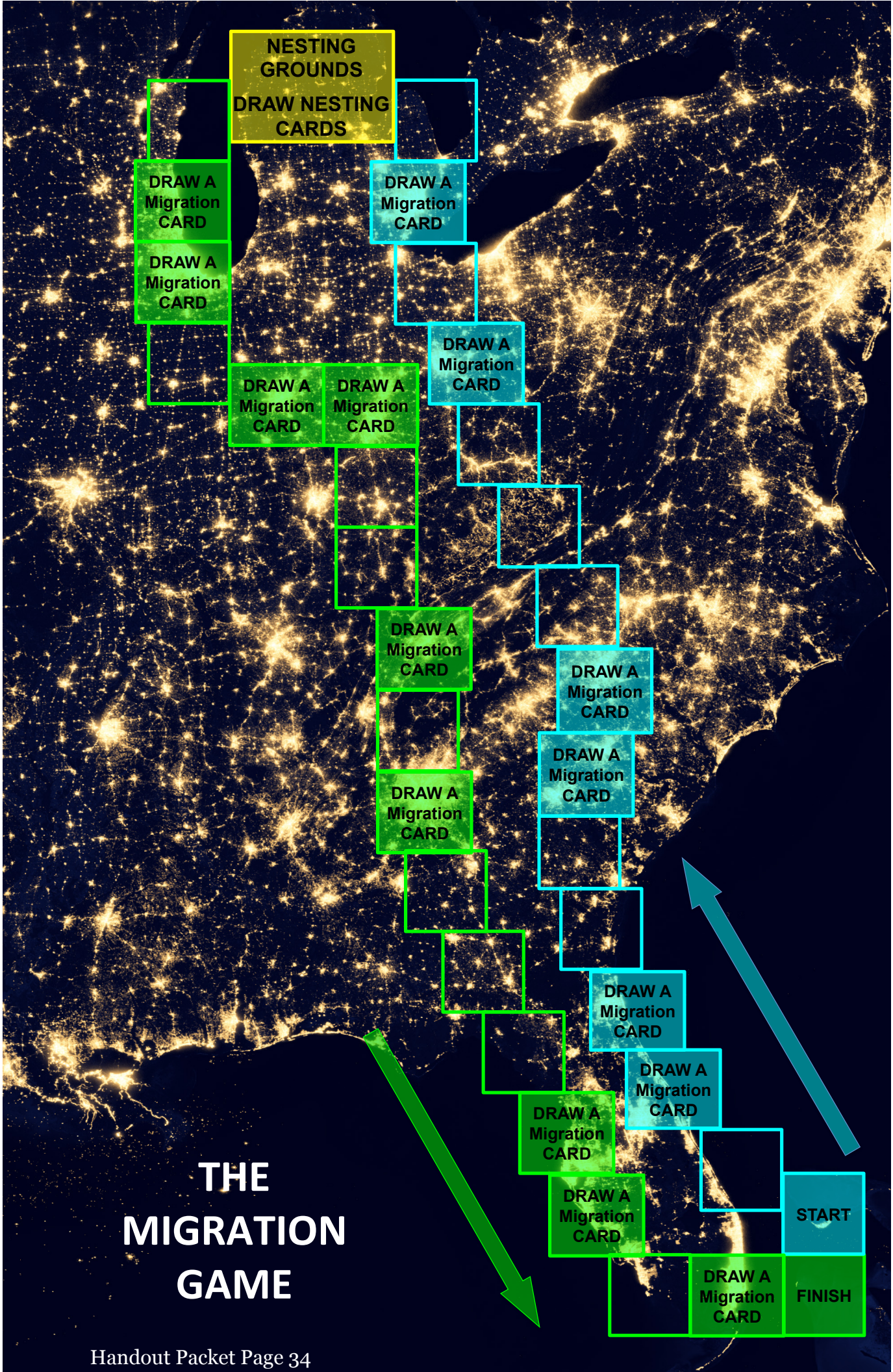
NESTING GROUNDS
DRAW NESTING CARDS
DRAW A Migration CARD
DRAW A Migration CARD
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DRAW A Migration CARD
DRAW A Migration CARD
DRAW A Migration CARD
START
DRAW A Migration CARD
FINISH
THE MIGRATION GAME

Shielded or Not?

Sort each of these lights into one of two categories: shielded (acceptable) or not shielded (unacceptable).

A

B

C

D

E

F

G

H

I

J

K 

L 

M 

N 

Sorting Game Answer Sheet

Shielded (acceptable)	Unshielded (unacceptable)
C, E, F, H, J, L, N	A, B, D, G, I, K, M

Better Lights for Better Nights

Help eliminate light pollution. Select the best fixture for your application using this guide.

presented by the
Texas Section of the International Dark-Sky Association
www.IDATexas.org

LIGHT TO PROTECT THE NIGHT

Five Principles for Responsible Outdoor Lighting

Illuminating ENGINEERING SOCIETY

IDA

USEFUL

ALL LIGHT SHOULD HAVE A CLEAR PURPOSE

Before installing or replacing a light, determine if light is needed. Consider how the use of light will impact the area, including wildlife and the environment. Consider using reflective paints or self-luminous markers for signs, curbs, and steps to reduce the need for permanently installed outdoor lighting.

TARGETED

LIGHT SHOULD BE DIRECTED ONLY TO WHERE NEEDED

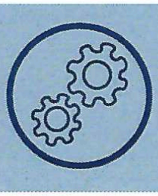
Use shielding and careful aiming to target the direction of the light beam so that it points downward and does not spill beyond where it is needed.

LOW LIGHT LEVELS

LIGHT SHOULD BE NO BRIGHTER THAN NECESSARY

Use the lowest light level required. Be mindful of surface conditions as some surfaces may reflect more light into the night sky than intended.

CONTROLLED



LIGHT SHOULD BE USED ONLY WHEN IT IS USEFUL

Use controls such as timers or motion detectors to ensure that light is available when it is needed, dimmed when possible, and turned off when not needed.

COLOR

USE WARMER COLOR LIGHTS WHERE POSSIBLE

Limit the amount of shorter wavelength (blue-violet) light to the least amount needed.

Problem-Solution Matching Game

Can you match each problem with each solution? Draw a line from each problem to the solution that fixes it!

Problem	*Solution*
A. Someone reads using a blue light heavy light right before going to bed.	1. Turn off the light or add a motion sensor so nearby animals and plants can grow properly.
B. A porch light is left on all night and moths are attracted to the light.	2. Turn off the light during the nighttime when it is not being used so insects are not attracted to it.
C. A light source can be seen from another property and creates light trespass.	3. By putting the light on a timer, we save money and energy.
D. A backyard firefly cannot see other fireflies' patterns because it is too bright.	4. Change the brightness of the lights so that they only light up what is needed.
E. An unshielded light creates glare and creates an unsafe environment.	5. Shield the light to reduce glare and increase safety.
F. A light left on all night stops a plant from growing in a healthy way.	6. Adjust the timing of the lights so that they are only on when they are useful.
G. A park closes at 10 PM, but leaves its lights on until 3 AM.	7. Shield the light source to reduce excess light spewing beyond where needed.
H. A living room lamp has the same level of brightness as a street light.	8. Shield and turn off lights nearby to darken the surroundings.
I. A porch light is a very bright, white light with lots of blue light.	9. Replace the light with a warmer temperature bulb to reduce exposure to blue light.
J. A light is left on all night and is wasting lots of energy.	10. Change the color temperature of the light to protect outdoor animals.

Matching Game Answer Sheet

Problem A -- Solution 9
Problem B -- Solution 2
Problem C -- Solution 7
Problem D -- Solution 8
Problem E -- Solution 5
Problem F -- Solution 1
Problem G -- Solution 6
Problem H -- Solution 4
Problem I -- Solution 10
Problem J -- Solution 3

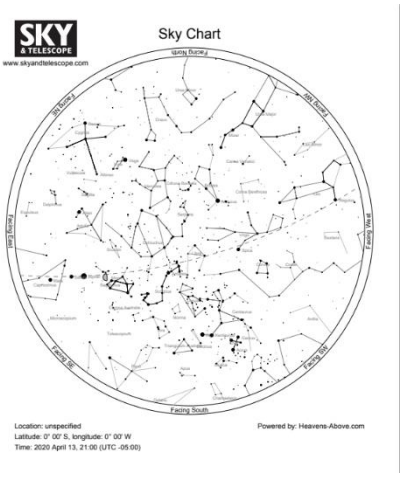
USE A SKY & TELESCOPE SKY CHART TO FIND OBJECTS IN THE NIGHT SKY

Overview (Activity Level of Difficulty: Easy)

A "sky chart" is a useful tool to identify stars and constellations in the night sky where you live. Sky charts are used by even the most experienced astronomers.

In this activity, download this FREE sky chart from Sky & Telescope. The Sky Chart can set to your specific viewing location and viewing time. Use the sky chart to identify and find stars and constellations in your night sky.

What You Need



- A "Sky Chart" from Sky & Telescope's website for the location, date and time that you plan to view the stars:
  - Visit https://skyandtelescope.org/interactive-sky-chart/
  - Enter information for your location and the date and time you expect to use the chart
  - Print the chart so that you can take it outside with you
- A flashlight to read the sky chart (a red light is preferable)
- Optional: A compass to help you find North

What to Do

1. Check outside to make sure the skies are relatively clear (few, if any clouds)
2. Confirm that you have the correct sky chart:
   a. The "date and time" on your sky chart matches your expected viewing date and time (Don't worry if your actual viewing date is a few days different but make sure the viewing time is a close match)
   b. The "location" for the sky chart is accurate for where you plan to view stars
3. Go outside with your charts and tools for the location, date and time entered on the sky chart
4. Find your darkest location for viewing the night sky. The best location will have:
   a. No buildings or trees blocking your view of the horizon
   b. No porch lights or streetlights that you can see
5. Find North:
   a. If you have a compass, use your compass to find North
   b. If you do not have a compass, face the direction of where the Sun set. Once facing the direction of sunset, turn a quarter turn to your right and you will be facing an approximate North.

USE A SKY & TELESCOPE SKY CHART TO FIND OBJECTS IN THE NIGHT SKY

6. Orientate your sky chart by doing the following:
    a. Find the Sky & Telescope logo on the chart
    b. Holding the sky chart in front of you, rotate the chart so that the Sky & Telescope logo is nearest the ground (see #1 in illustration to right)
7. Hold your chart in front of you with both hands:
    a. With the Sky & Telescope logo nearest the ground as shown in illustration to the right as #1, use your thumb to cover the words “Facing North”
    b. With your other hand, grasp the side of the chart opposite of the Sky & Telescope Logo (see #2 in illustration to the right). Use your thumb from that hand to hold the side with the words “Facing South”.
    c. By holding the chart with both hands, your chart will straighten out and be easier to read.

8. Continuing to hold the chart in front of you with both hands as noted above:
    a. Face the direction of North
    b. Look above you at the night sky
    c. Continuing to face North and holding the chart with both hands, raise the chart directly above you so that are looking up at the sky while also looking at the chart.
9. Your chart is now ready to use:
    a. The stars and constellations above you will match what you see on the chart.
    b. The dashed line called the “ecliptic” that traces across the chart is the Sun’s path during the day. This is where the planets and Moon will be at night, if they are available

Did You Know

As the Earth travels around the Sun and rotates as part of our day/night cycle, the stars rise four minutes earlier each night. This slight shift in the night sky each evening may not seem like much but will cause the sky above us to completely change with every change season.

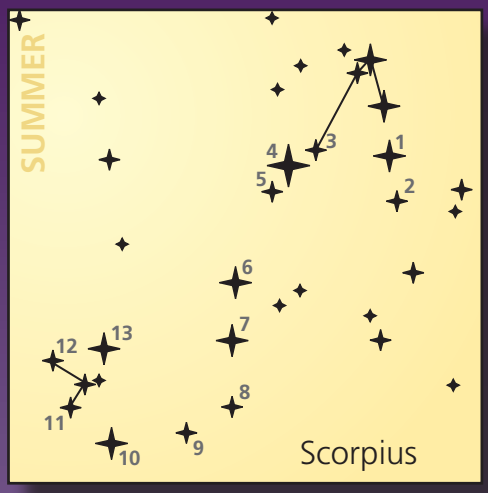
Learn more: https://www.space.com/10821-night-sky-changing-seasons.html

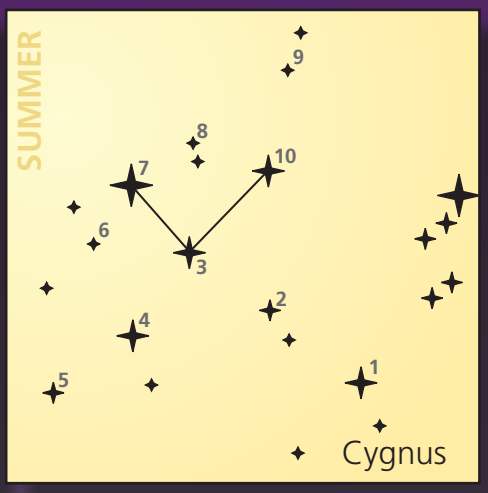
More Resources

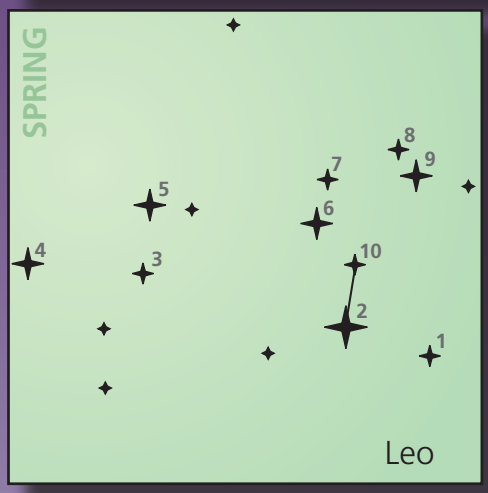
- Visit https://skyandtelescope.org/ to learn more about viewing the night sky.
- Download another popular sky chart from www.skymaps.com

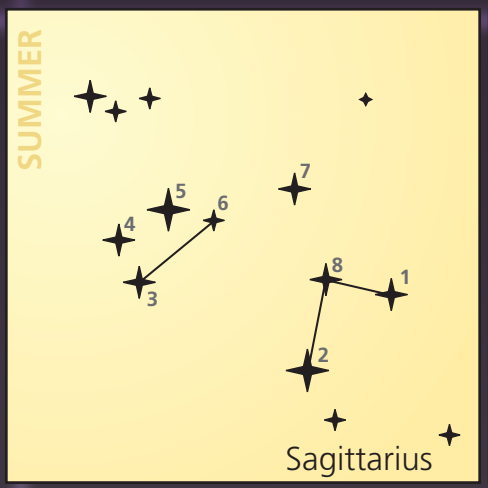
Constellation riddles

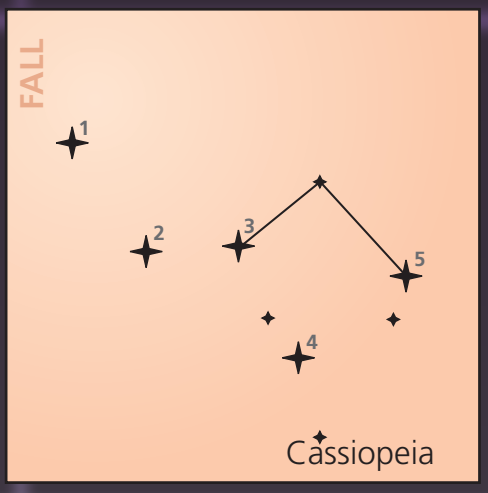
★ Draw the shape of each constellation by connecting the numbered stars in order.
★★ Connect the stars and write the name of each constellation next to its story below.











I am a mighty hunter. I hunt with a club 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 an eight-legged creature with powerful claws and stinger. I'm on a mission to chase the hunter across the sky 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 _ _ _ _ _

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

How dark is the sky?

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 your 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 this book to help you find these constellations.)