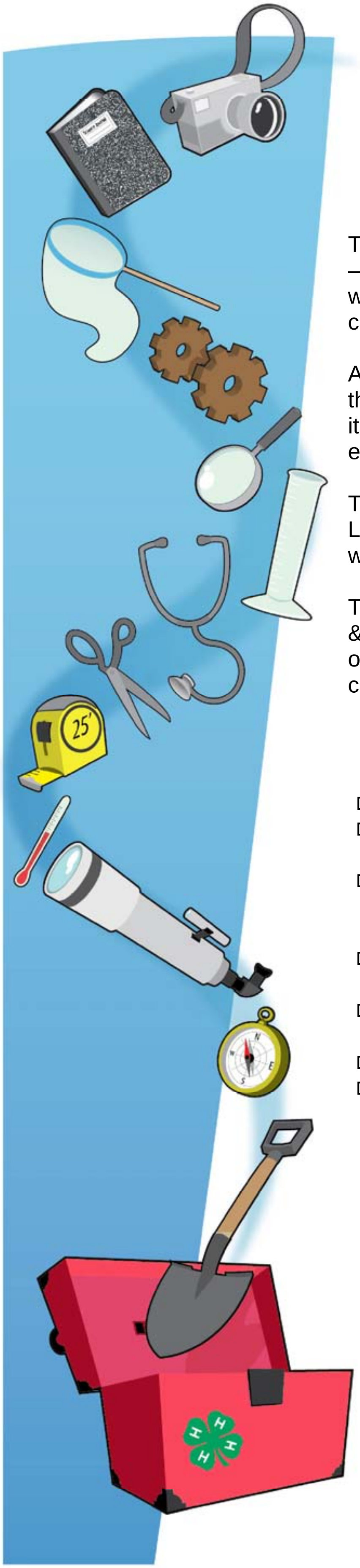


Astronomy 1:
Sky Gazing

About the 4-H Science Toolkit Series: Sky Gazing

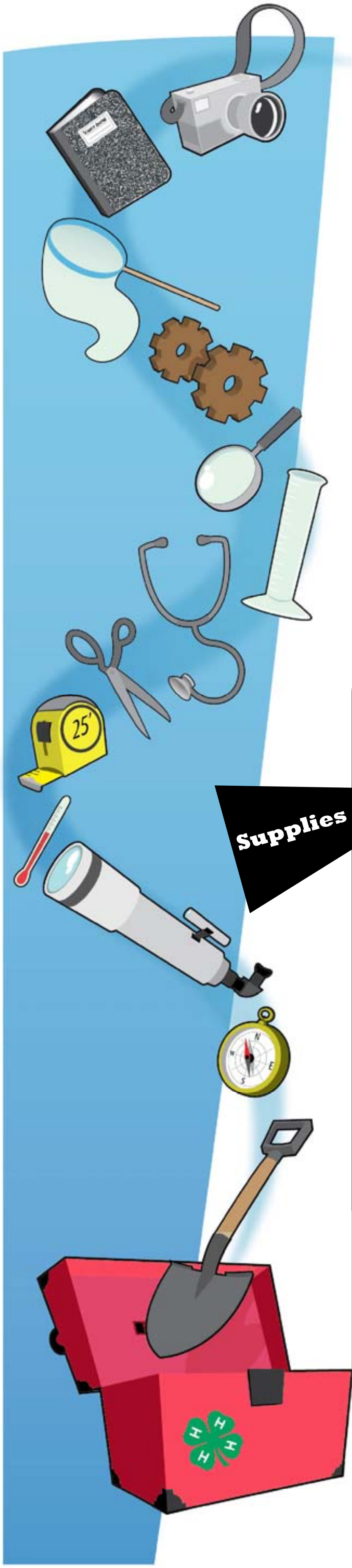
This series of activities focuses on a subject of fascination to both children and adults – astronomy – our Solar System and beyond. Through the activities, children will learn what scientists have discovered about our universe and feel both a sense of awe and connection to our world each time they look at the stars.

All of these adventures call on students to predict what will happen, test their theories, then share their results. They'll be introduced to astronomy vocabulary, make several items they can take home to expand their adventures and come home armed with enough knowledge about the night sky to share with their family.

The lessons in this unit were adapted from "Astronomy – It's Out of this World" 4-H Leader/Member Guide by Brian Rice. This guide is available online at http://www.ecommons.cornell.edu/handle/1813/3487.

To find out more about astronomy activities, visit the Cornell Center for Radiophysics & Space Research education and public outreach web site at http://astro.cornell.edu/outreach/ and to find numerous resources related to astronomy and other sciences, check out the national 4-H Resource Directory at http://www.4-hdirectory.org.

Sky Gazing Table of Contents



Astronomy 1: Sky Gazing
Telescopes

Activity Series:: Astronomy 1
Grade: 3-6
Time: 45 min

Main Idea
These experiments show how a simple refracting telescope works and how the image is flipped upside down and reversed.

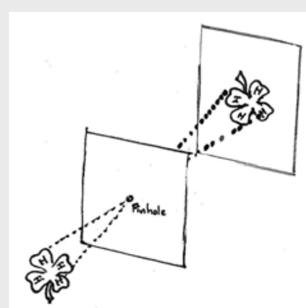
Motivator
More than 400 years ago (1609), Galileo turned a simple telescope to the sky and astronomy was never the same. Without the telescope, we would understand little about our solar system and the universe. We're going to do two experiments to discover how a refracting telescope works and what happens to the image. Galileo's telescope had two lenses, which is called a refracting telescope .

Pre-Activity Questions
Before you start the activity, ask the students:
- ❑ Have you ever looked through a telescope? How big was it? What did you see?
- ❑ Do you know how a telescope works? (There are two basic kinds of telescopes - reflecting and refracting.)

Activity

Supplies

- ❑ Magnifying glasses or other convex lenses (2 for each telescope model).
- ❑ Pringles can, oatmeal canister, or other cardboard tube (make one demo model or more)
- ❑ Tracing paper or wax paper
- ❑ Rubber bands
- ❑ Sharp knife and pin
- ❑ Aluminum foil
- ❑ Transparent tape
- ❑ Darkened room
- ❑ Candles or neon-shaped bulb or mag flashlight with end removed to use like a candle or use objects outdoors



Activity 1 - A Pinhole Viewer
1. Using the knife, cut a 1/2 hole in the bottom of the container (if the container does not have a lid, you may need to cover the end with heavy dark construction paper or cardboard).
2. Cover the hole with aluminum foil and poke a hole in the center of the foil with the pin.
3. Cover the open end of the container smoothly with the tracing paper or waxed paper and secure it with a rubber band.
4. Darken the room and point the pinhole end of the viewer at the candle or light and observe the image on the tracing paper.
5. Everyone should try it and then the group can discuss what they saw and try to explain what is happening.

Objectives
- Understand how a refracting telescope works.
- Discover how images are changed when viewed through two lenses.

Learning Standards
(See Matrix)

Common SET Abilities 4-H projects address:
Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

Contributed By
Nancy Schaff, Cornell Center for Radiophysics & Space Research in the Department of Astronomy

Astronomy 1
Telescopes

Activity 2 - A Simple Telescope
1. Take one magnifying glass or lens in each hand.
2. Hold one glass close to your eye (approximately 3 inches).
3. Hold the other lens approximately 1 foot away.
4. Move the farther lens until the objects seen through the lens come into focus. Everyone should get a chance to try this.

Science Checkup - Questions to ask to evaluate and extend learning

Pinhole Viewer:
- ❑ What happens to the image?
- ❑ Why does this happen?

Telescope:
- ❑ How is this experiment similar to a refracting telescope?
- ❑ What happens to the image?
- ❑ Are the objects larger or smaller?
- ❑ How can we explain the changes?

Extensions

- Purchase a simple refracting telescopes. They show how telescopes work, but are not of astronomical quality. One source is Science First® (about $60 for 10).
- Visit an observatory to look through a telescope at night.
- Contact a local amateur astronomy group to invite someone to meet with your club and bring a telescope.
- Check out MicroObservatory at http://mo-www.harvard.edu/OWN/ Remote telescopes are available online for free. Request an image and it will be sent to you.

Vocabulary

Reflecting or Reflector Telescope: An optical telescope that uses a curved mirror or mirrors to reflect light and form an image
Refracting or Refractor Telescope: An optical telescope that uses a lens to form an image
Refraction: Bending light causing parallel light rays to converge a a focal point.
Focal point: The point at which rays of light meet after passing through a convex lens

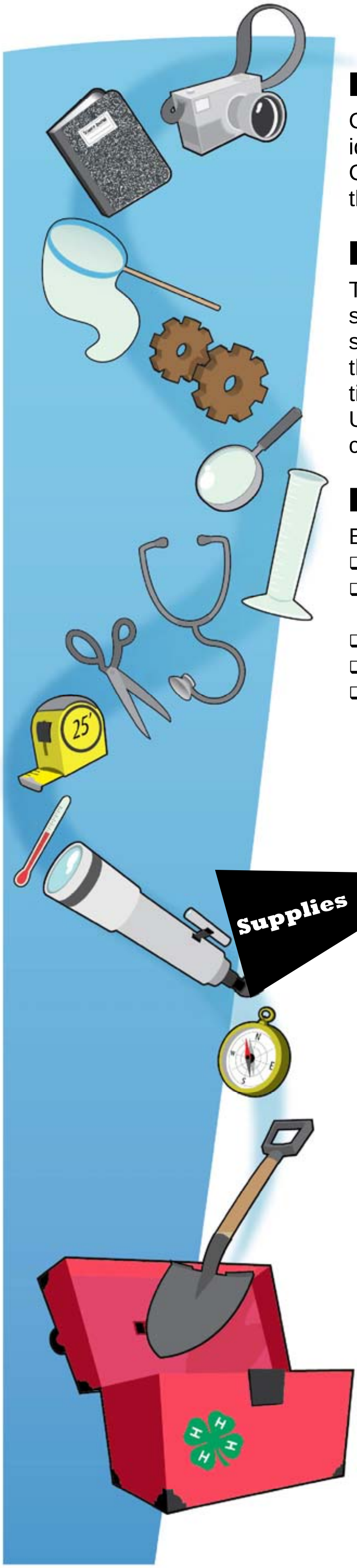
Background Resources

The first telescopes, such as Galileo used, were made from two lenses in a tube. Galileo did not invent the telescope, but is credited with being the first person to use it as an astronomical instrument in 1609. He was one of the first modern scientists - he collected evidence (data) to support scientific claims. Professional astronomers do not spend their time looking through telescopes. Cameras and other instruments capture the images from large telescopes in space and on the tops of high mountains (to be above as much atmosphere and water vapor as possible).

Astronomy 1: Sky Gazing

Constellations in a Can

Activity Series:: Astronomy 1
Grade: 2-6
Time: 45-60 min



Main Idea

Constellations have fascinated humans throughout history and are fun to identify and teach to others, but it takes practice to learn them. Constellations help us tell stories, find stars in the night sky, and identify the season.

Motivator

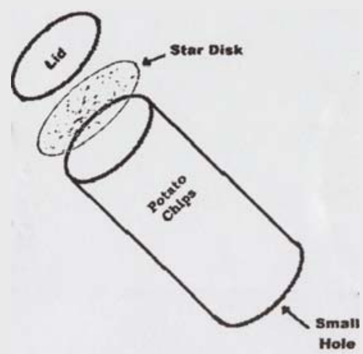
Throughout human history, people in all parts of the world have observed the stars. By associating groups of stars with a character from a story, it made it easier to remember where star patterns were located in the sky. The ancient constellations helped people to note the passage of time, navigate and remember important mythological stories and events. Using the sky as a calendar and timekeeper was a strong part of many cultures.

Pre-Activity Questions

Before you start the activity, ask the students:

- How many stars are there in our Solar System? (one, the Sun)
- What is a star? (A hot ball of hydrogen and helium gas that shines because of nuclear reactions in its core.)
- Do you recognize any constellations when you look at the sky?
- Are all stars in a constellation the same distance from Earth? (No)
- Why don't we see stars during the day? (the sun is too bright)

Activity



- A Pringles® can for each participant, with clear plastic lid (or cardboard tube)
- Black construction paper
- Hammer
- Large nail
- Copies of the constellation templates
- Pin or needle
- Decorating materials (optional)

1. Use the large nail and the hammer to punch a hole into the bottom (the metal end) of the Pringles can.
2. Place the end of the can on top of the construction paper and trace a circle around the outside of it. You may want to make several circles for different constellations.
3. Now line up the constellation template/s with the circle/s of construction paper that you have drawn, and poke holes in them using the needle or pin, on the places that stars are indicated.
4. Cut out the circle(s).
5. Place one of the circles that you have cut out into the lid of the Pringles can and recap it.

Objectives

- Learn to identify and show others a few well-known constellations
- Learn more about stars.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

Contributed By

Nancy Schaff,
Cornell Center for Radiophysics & Space Research in the Departmet of Astronomy

6. (Optional) Decorate the can with whatever materials you have (leftover wrapping paper works well).
7. To view the constellation, point the capped end towards a light and look through the hole in the base of the can.

Alternative Method: *If you cannot obtain Pringles cans, a toilet paper or paper towel tube can be used. Tape black construction paper or a double layer of black tissue paper to both ends. Poke star holes through one end (you will need to shrink down the constellation template to a smaller diameter), punch a nail hole in the other end, and decorate.*

Science Checkup - Questions to ask to evaluate and extend learning

- ❑ Why have people named patterns of stars throughout history and created stories about them? Was it useful to be able to identify different constellations at different times of the year? If so, why?
- ❑ Do you think you can go outside and find a constellation? Do you know any well enough to find them in the night sky?
- ❑ How many stars are in our Solar System? (One, the Sun.) How many stars are there in the Milky Way Galaxy? (billions) All of the stars we see in the night sky are in the Milky Way Galaxy.
- ❑ Are the stars we see all the same size and distance from Earth? (No, there are many different sizes with different brightnesses and different distances from Earth.)
- ❑ Are there different colored stars? (Yes, blue stars are very hot and don't live long; red stars are cooler; our yellow star, the Sun, is a medium-sized star and will live a long time.)

Extensions

- Learn more about constellations by picking a favorite, learning the story behind it and sharing it with others.
- Observe the sky on a clear night and make up your own constellations.
- Create a Constellation activity – from the Pacific Science Center
- http://www.pacsci.org/download/astro_ad_constellation.pdf
- Try activities from the Lunar & Planetary Institute "*Sky Tellers*" constellation unit http://www.lpi.usra.edu/education/skytellers/constellations/

Vocabulary

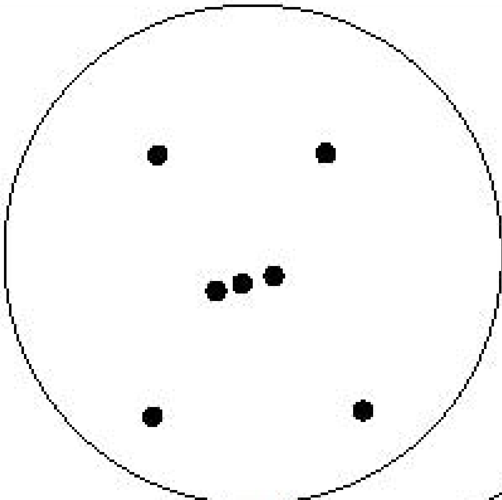
Constellation: A group of stars that, when viewed from the earth, appears as a pattern. They are usually named for mythological gods, people, animals and objects. Modern astronomers divide the sky into 88 regions called constellations that contain named star patterns.

Background Resources

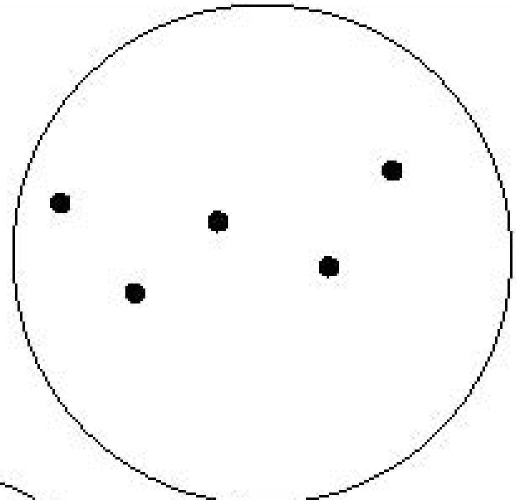
- Constellations are imaginary patterns in the sky that poets, farmers and astronomers have named over thousands of years. Many of them were named after ancient gods, creatures and objects in Greek myths. Some historians suspect that many of the myths associated with the constellations were invented to help farmers remember them.
- In some regions of the world, there is not much differentiation between the seasons. Since different constellations are visible at different times of the year, farmers used them to tell what month it was. When they saw certain constellations, they would know it was time to begin the planting or the reaping.

Worksheet 7.1

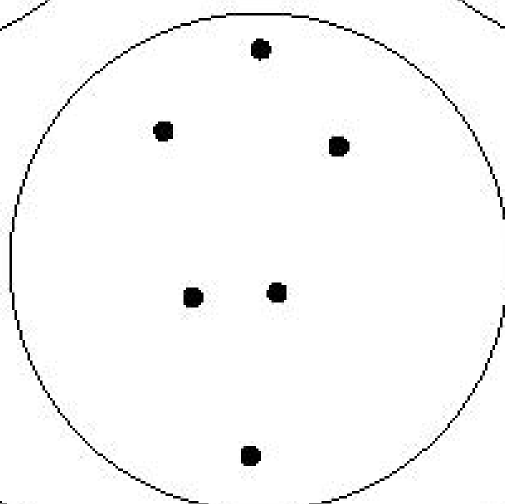
Constellation Patterns



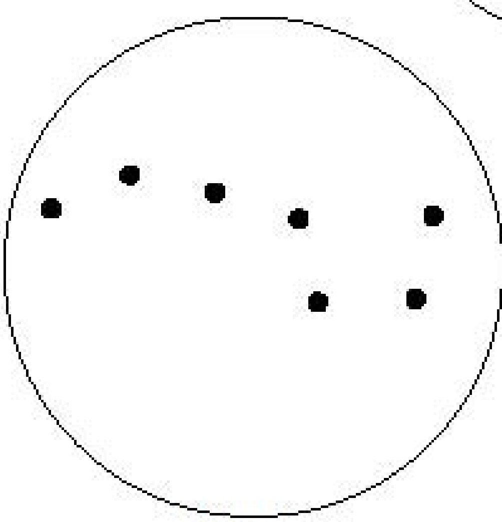
Orion



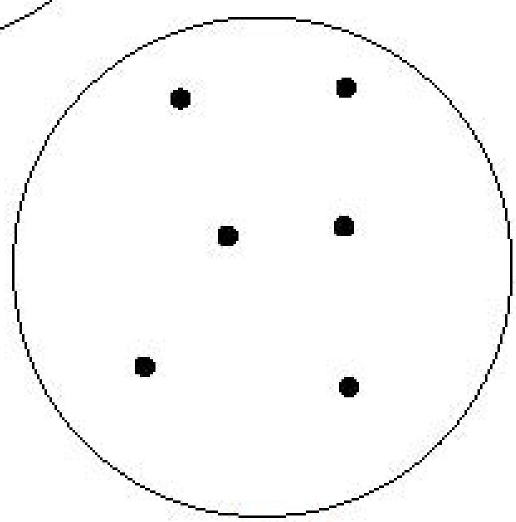
Cassiopeia



Boötes



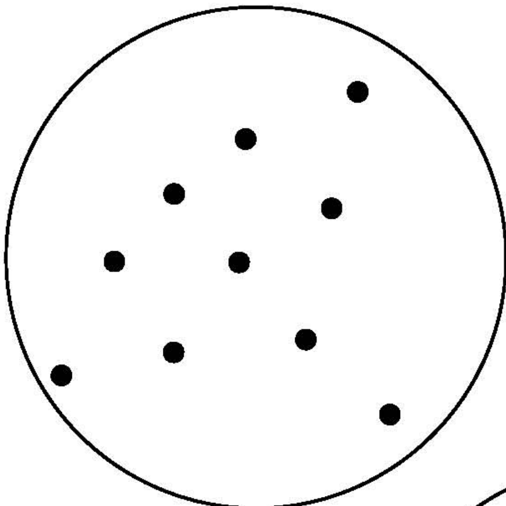
Ursa Major



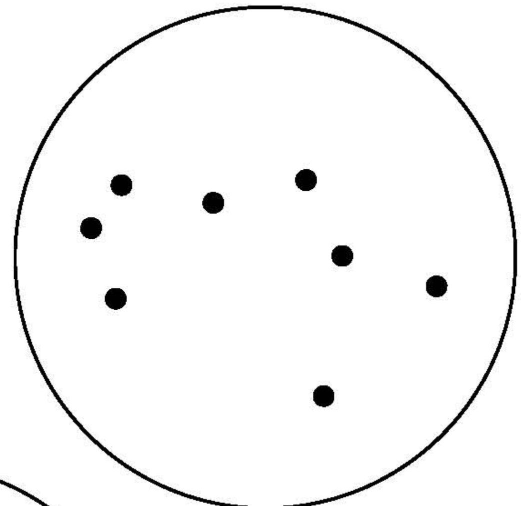
Hercules

Worksheet 7.2

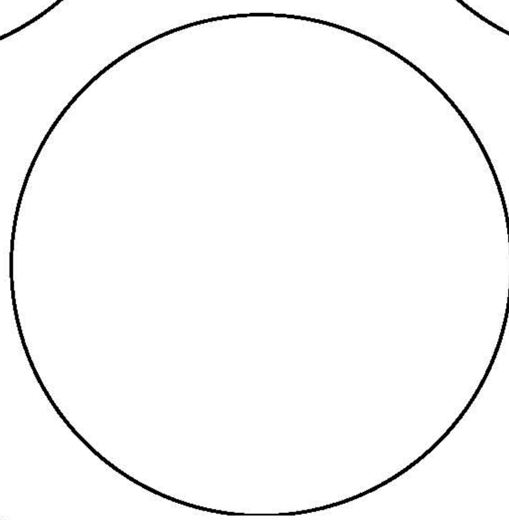
More Constellation Patterns



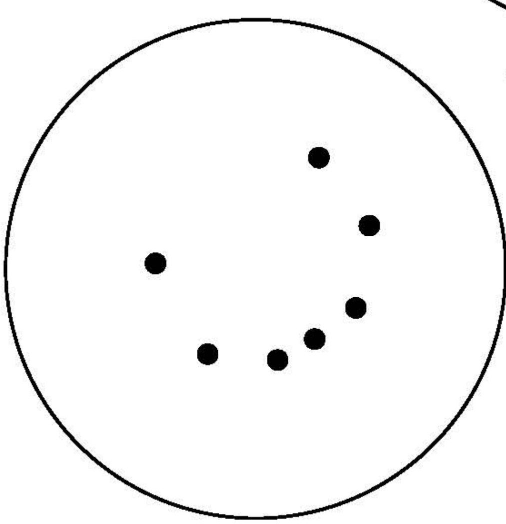
Cygnus



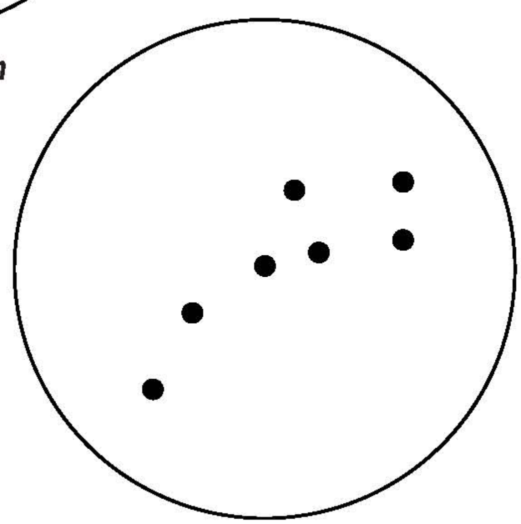
Sagittarius



Make Your Own



Corona Borealis



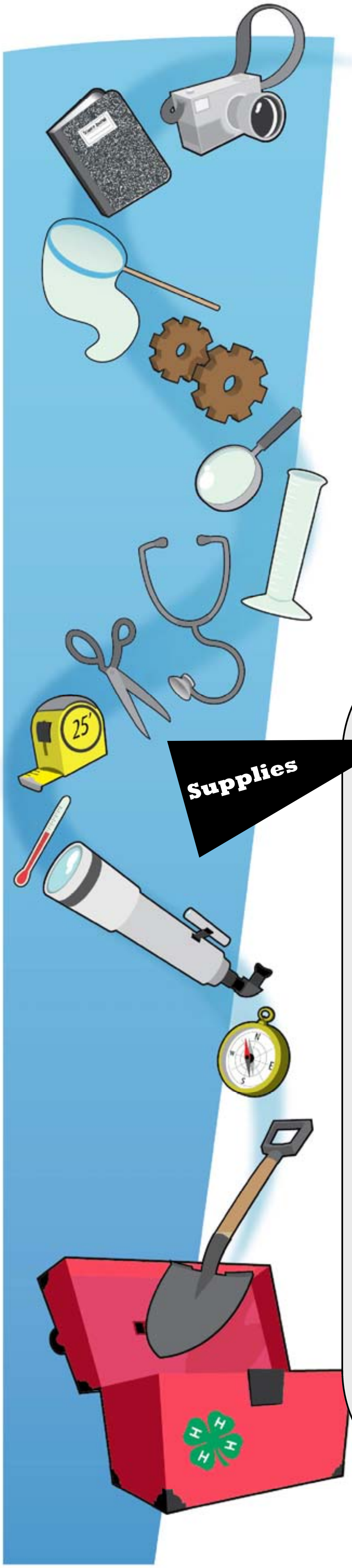
Ursa Minor

4-H Science Toolkit

Astronomy 1: Sky Gazing

Making a Star Chart

Activity Series:: Astronomy 1
Grade: 3rd & up
Time: 45-60 minutes



Main Idea

Constellations have fascinated humans throughout history and are fun to identify and teach to others. A star chart can be used to find constellations and objects in the sky.

Motivator

On a really dark night, you can see about 1,000 to 1,500 stars. Trying to tell which is which can be hard, so constellations are used as mnemonics, or memory aids.

Pre-Activity Questions

Before you start the activity, ask the students:

- ❑ What experiences have you had observing the sky?
- ❑ Will we be able to see every star on the chart? Why? (No. Some won't be bright enough. Some are below the horizon.)
- ❑ Why do the constellations we see in the sky change throughout the night and the year? (Because the Earth is orbiting the Sun and rotating.)
- ❑ Are all of the stars we see in a constellation at the same distance from Earth? (No) Are they all in the Milky Way? (Yes)

Activity

- ❑ Copies of star chart on cardstock or regular paper pasted to cardboard. It is also available at http://lawrencehallofscience.org/starclock/starwheel.pdf or other sites
- ❑ Tape or stapler
- ❑ Scissors
- ❑ Optional constellation activity sheets

1. Cut along the black outer circle of the Star Wheel and along the solid lines of the Star Wheel holder. Remove the interior oval shape on the Star Wheel holder.
2. On the Star Wheel holder, fold the cardboard along the dashed lines.
3. Tape or staple along the edges of the holder, forming a pocket.
4. Place the Star Wheel in the Star Wheel holder (it should be able to move freely.)

Example of a commercial planisphere

Use of the star chart *

a. Line up today's date with the time you will be stargazing. The viewable piece of the star chart is what your sky will look like when held up to the sky.
b. Help participants practice using the star chart by locating constellations on the map that you want to find in the sky.
c. Turn your map so that the horizon that the constellation is closest to is at the bottom. The star positions in the sky should match those on the wheel.

Objective

- Construct a star chart that can be taken home and used to observe the night sky.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate

Contributed By

Nancy Schaff, Cornell Center for Radiophysics & Space Research in the Department of Astronomy

Astronomy 1

Making a Star Chart

** Note: If you live in a city or someplace where there is a lot of light pollution, many of the stars on the chart won't be visible in your night sky. Orion's belt and the Big Dipper (Ursa Major) are some of the easiest constellations to find because people recognize them and they include bright stars.*
Do the matching and crossword constellation activities, if desired. (These could also be take home activities.) There are additional supplemental resources and activities in the appendix that leaders can use when stargazing with youth.

Science Checkup - Questions to ask to evaluate what was learned

- ❑ Make up your own practice questions, using the star chart, and have the students try to figure out the location of certain constellations on specific days and times. For example:
  When is Scorpio in the southwestern horizon at 10 p.m.? (Around Aug. 15)
  Where is Draco on January 20 at 9 p.m.? (The northern horizon)

Extensions

- Visit NASA Space Place Web site and print the folding fortune teller star finder for the appropriate month: http://spaceplace.nasa.gov/en/kids/st6starfinder/st6starfinder.shtml
- Participate in one of the Star Count programs as a citizen science project:
  The Great Worldwide Star Count: http://www.windows.ucar.edu/citizen_science/starcount/
  Globe @ Night: http://www.globe.gov/GaN/
  NASA Star Count: http://www.nasa.gov/audience/foreducators/son/energy/starcount/index.html
- Check out the Lunar & Planetary Institute Sky Tellers "Stars" and "Polaris" activities:
  http://www.lpi.usra.edu/education/skytellers/
- Listen to the Jet Propulsion Laboratory "What's Up" podcasts and vodcasts:
  http://www.nasa.gov/multimedia/podcasting/whatsup_index.html
- Check out Google Sky or one of the many other programs on the Web that show the night sky.
- If you have an amateur astronomy club in your area, you may be able to find a mentor for astronomy activities and/or arrange for an opportunity for the group to observe through a telescope.

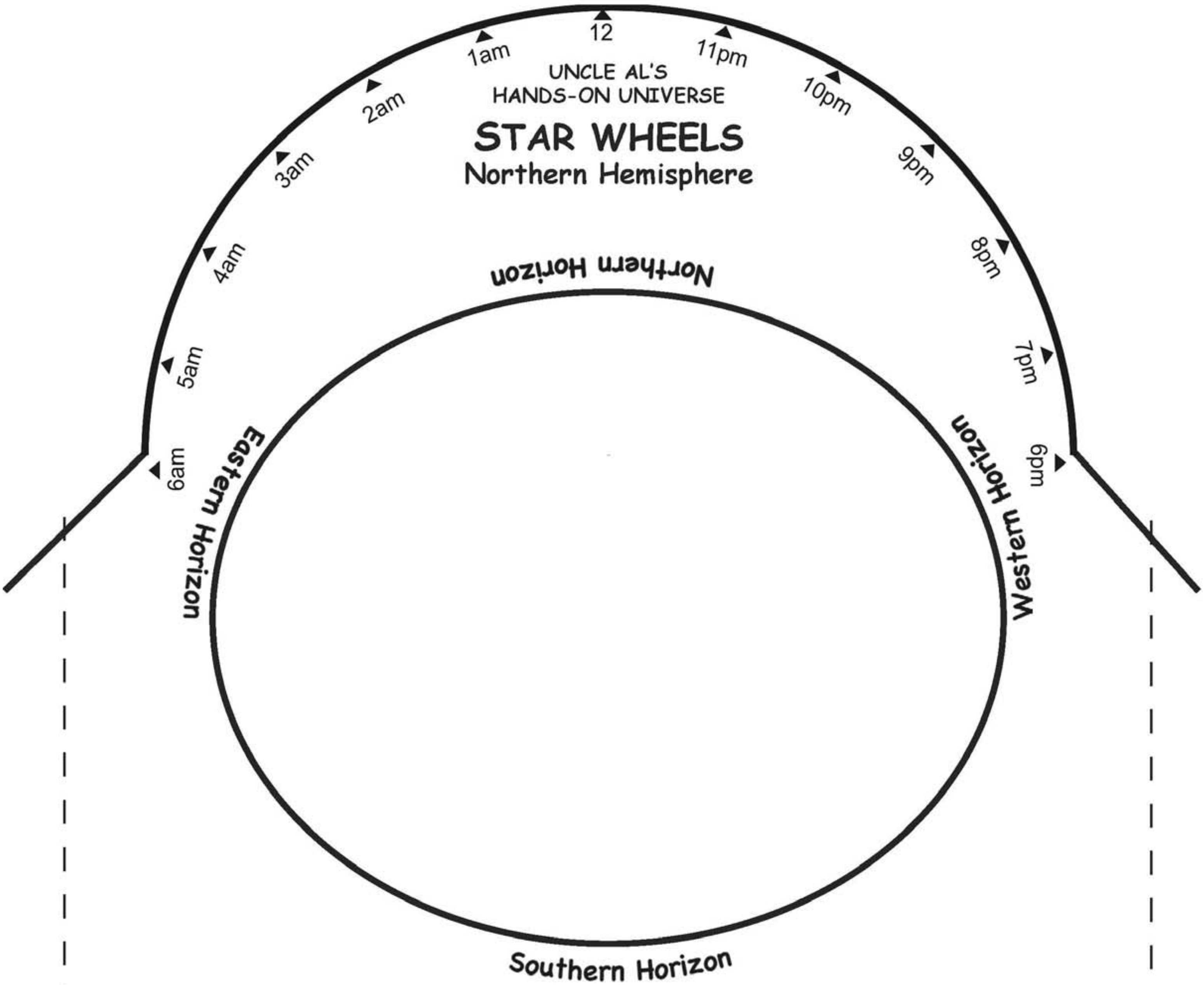
Vocabulary

Constellation: A group of stars that, when viewed from the Earth, are in an obvious pattern and are usually named for mythological gods, people, animals and objects. Astronomers also divide the sky into 88 regions called constellations that contain these named star patterns.
Light year: The distance that light can travel over the course of one year — almost 10 trillion kilometers or more than 5 trillion miles!

Background Resources

- Constellations are imaginary patterns in the sky that poets, farmers and astronomers have named over thousands of years. Many of them were named after ancient gods, creatures and objects in Greek myths. The stars have been tracked and looked at with wonder for thousands of years, and you can follow in this age-old tradition with your own star chart.
- Our modern constellations come from a list of 48 constellations that were described by the Greek astronomer Ptolemy in 150 AD to illustrate stories in Greek mythology. Over the centuries, navigators and celestial mapmakers reworked the system of constellations and expanded the list to include star patterns that can only be observed from the southern hemisphere. They also filled in the gaps between the constellations recognized by the Greeks.
- The stars that make up a constellation don't have a physical connection with one another and are usually at very different distances from the Earth.

Star Wheel Holder

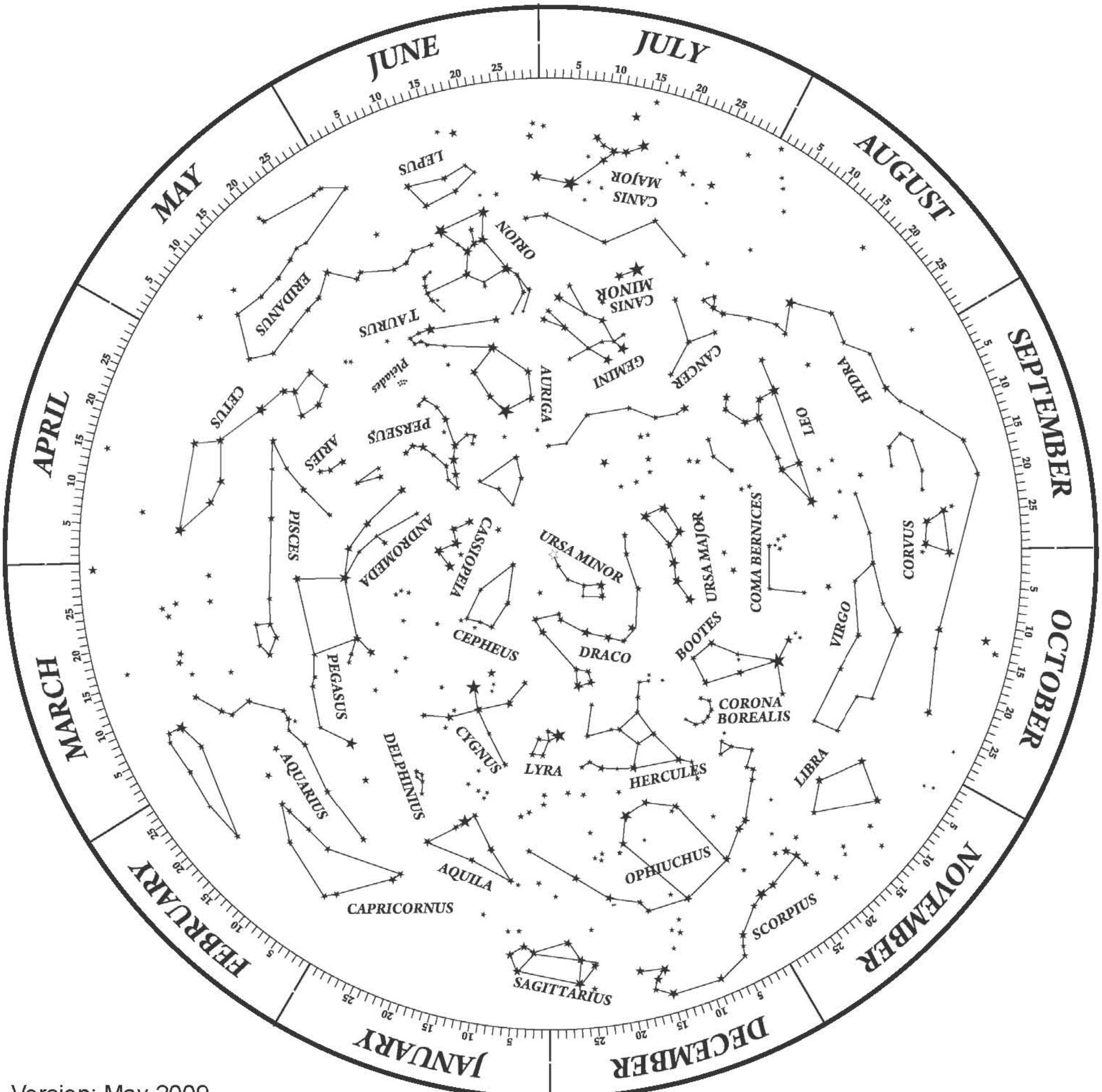


Version: May 2009

Download Uncle'Al's Sky Wheels from http://lhs.berkeley.edu/hou/img/uncleal
510-642-1016 http://www.lhs.berkeley.edu/pass/ast110&111&121.html
available through LHS Museum Store
Uncle Al's Star Wheels are based on LHS Sky Challengers created by Budd Wentz and

4. The star positions in the sky should match those on the wheel.
3. Turn your map so the horizon it is closest to is at the bottom.
2. Locate the constellation you want to find on the map.
1. Align your date and time, and then look up at the sky

Instructions for Using Uncle Al's Star Wheels



Version: May 2009

INSTRUCTIONS FOR ASSEMBLING UNCLE AL'S STAR WHEELS

Step 1: Print out all pages either on heavy cardstock or paste them onto a file folder or any other sturdy piece of cardboard.

Step 2: Cut along the black outer circle of the Star Wheel and along the solid lines on the Star Wheel Holder. Remove the interior oval shape on the Star Wheel Holder.

Step 3: On the Star Wheel Holder, fold the cardboard along the dashed lines.

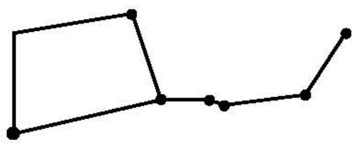
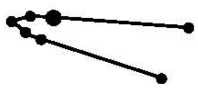
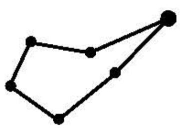
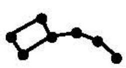
Step 4: Tape or staple along the edges of the Star Wheel Holder forming a pocket.

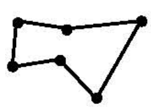
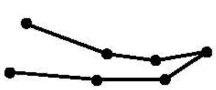
Step 5: Place the Star Wheel in the Star Wheel Holder.

Uncle Al's HOU Star Wheels are based on LHS Sky Challengers created by Budd Wentz and available through the LHS Discovery Corner Store 510-642-1016
http://lhs.berkeley.edu/pass/AST110&111&121.html
Download Uncle'Al's Sky Wheels from http://lhs.berkeley.edu/starclock/skywheel.html

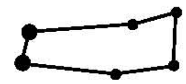
Worksheet 1.3

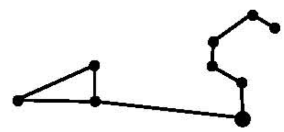
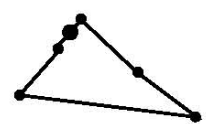
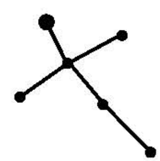
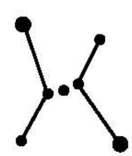
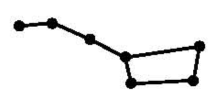
Constellation Matching

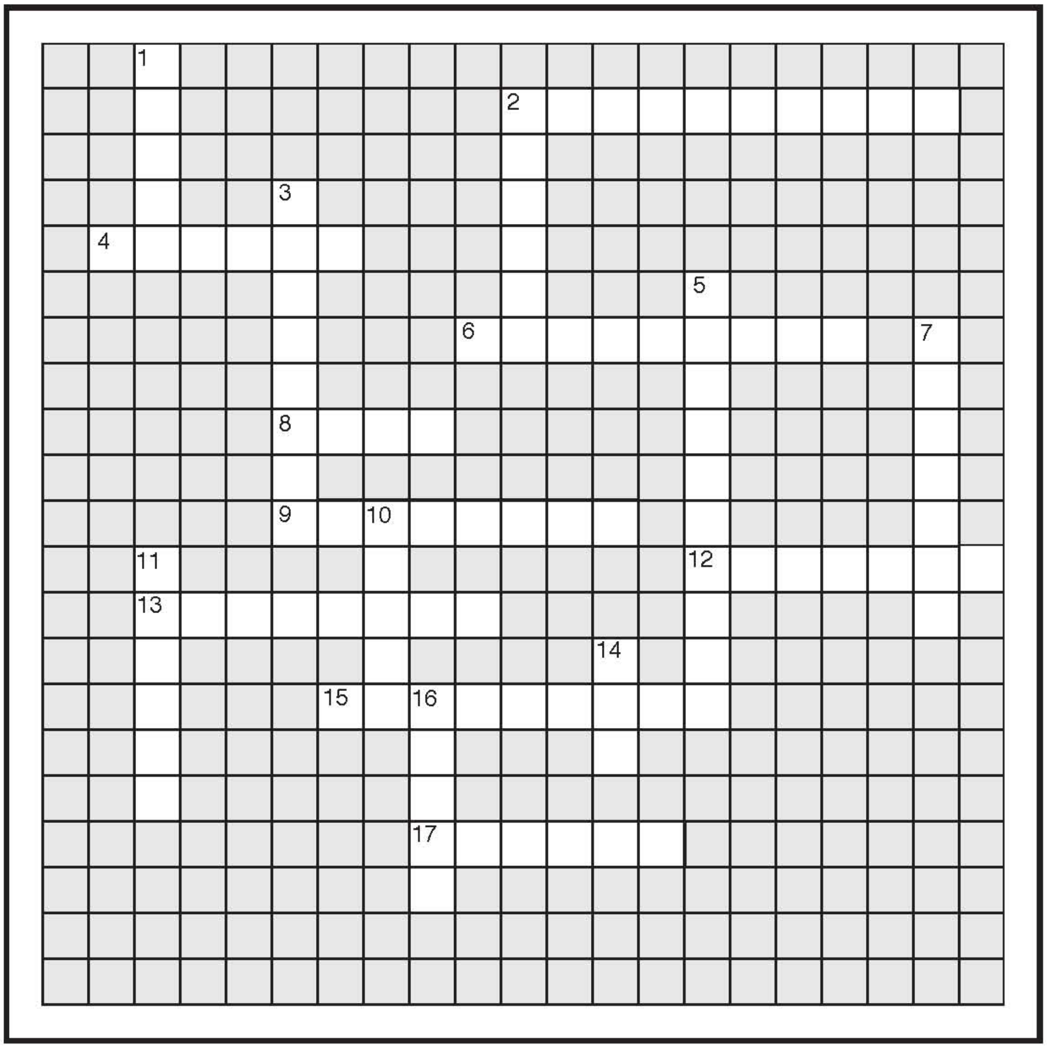

1. Aquila
2. Hercules
3. Corona Borealis
4. Ursa Major
5. Ursa Minor
6. Leo
7. Gemini
8. Boötes
9. Orion
10. Taurus
11. Pleiades
12. Cassiopeia
13. Andromeda
14. Pegasus
15. Cygnus
16. Lyra



Worksheet 1.4

Mythology Crossword Puzzle



Clues

Across

2 The Little Dog
4 The Shepherd
6 The Big Bear
8 The Harp
9 Killed Orion
12 Killed Medusa
13 The Water Bearer
15 Beautiful Princess Saved by Perseus
17 The Swan or The Northern Cross

Down

1 The Maiden
2 The Crab
3 Greek Hero or Son of Zeus
5 Queen of Gods
7 Mythical Winged Horse
10 The Great Hunter
11 Animal Attacking Orion, or The Bull
14 King of the Animals
16 The Dragon

Answers on back

Astronomy 1: Sky Gazing

Going Through a Phase: Moon Phases

Activity Series: Astronomy 1
Grade: 3rd & up
Time: 45-60 minutes

Objectives

- Understand why the Moon appears to go through phases each month.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

Main Idea

The moon's phases are a commonly misunderstood occurrence. As the position of the moon changes in relation to the Earth and the Sun, the amount of the moon's lit surface that we see changes.

Motivator

Have you ever wondered why sometimes the Moon appears just as a sliver and sometimes it's a whole circle? Is the Moon really changing size or shape?

Pre-Activity Questions

Before you start the activity, ask the students:

- ❑ What is the moon made of? (Rocks similar to those on Earth, but the moon has no atmosphere, 1/6 the gravity of Earth, and no liquid water.)
- ❑ Why does it shine? (It reflects light from the Sun.)
- ❑ Do other planets have moons? (All planets except Mercury and Venus have moons. Earth is the only planet with just one moon.)
- ❑ What do you think causes the phases? (Accept all answers, then explain they are going to make a model to demonstrate what causes the moon's phases to conclude which idea is correct.)

Activity

Supplies

- ❑ Lamp without a shade or clamp lamp
- ❑ softball or large polystyrene ball on a stick
- ❑ A dark room
- ❑ Alternatively, you can use *polystyrene balls (2" or larger) or golf balls superglued to golf tees for each person, held with a stick or pencil

1. You will need a room that can be darkened. Darken the room after you have everything set up and have provided instructions.
2. Place the lamp so that the bulb is approximately at head level with the participants (or squat so head is at level of light).
3. Give one person (who is representing the Earth) the softball (representing the moon) and have them stand facing the lamp with the ball held at arm's length and positioned just below the light bulb. If you are using polystyrene balls for each participant, have them stand in a circle around the bulb and do the activity simultaneously.
4. The phase that they started in facing the bulb was the New Moon phase. The ball should appear dark.

- *Polystyrene is smoother and denser than styrofoam and reflects light better. (Styrofoam won't work.)*

Contributed By

Nancy Schaff, Cornell Center for Radiophysics & Space Research in the Department of Astronomy

Moon Phases

5. Now have them turn slowly around to the left (counterclockwise) to go through the phases and have them name each phase. A good way to teach "counterclockwise" is the "right hand rule" – hold your right hand out in front of you, stick your thumb up in the air and curve your fingers. The way your fingers are pointing is counterclockwise – the direction most objects in the Solar System rotate and orbit.
6. After the first person has had an opportunity to see the phases, then pass the ball on to the next person and repeat the process (unless each person has a ball.)
7. Make copies of the moon phase pictures on page 4. In groups, have participants cut out the pictures, put them in order and add names of phases. A key is provided for the leader. (You could try this before steps 1-6 and come back to it.)
8. Try the activity with the ball and light again to reinforce or check answers for phase names and order of phases.

Science Checkup - Questions to ask to evaluate what was learned

- Does the moon rotate? (Yes! This is confusing to many people, since we always see the same side of the moon. The moon is in "synchronous rotation" with the Earth. This means that the moon takes as long to rotate on its axis as it does to make one orbit around the Earth. Therefore the same hemisphere is always pointed toward the Earth. If the Earth did this, a day and year would be the same length of time! You can demonstrate this by having one person (the Earth) turn around in a circle standing in place with another person (the Moon) walking around the Earth in an orbit. The two people always face each other (we always see the same side of the Moon). Although it doesn't seem like it, the outside person is rotating as she orbits. (She can confirm this by noting that the background changes.)
- How have people used the phases of the Moon throughout history? (farming, other ideas?)
- What causes the moon to shine? (reflected light from the Sun)
- Can you think of examples of holidays that are scheduled based on the phase of the moon? (Easter, Chinese New Year, Passover …)

Extensions

- Have youth observe the phases of the Moon and record them for a month. This would be a good activity to do before the demonstration of Moon phases described above because it provides data and evidence for their ideas about moon phases.
- Try the ***Sky Tellers*** **moon phases activities**: http://www.lpi.usra.edu/education/skytellers/moon_phases
- **Windows to the Universe:** Moon Phases www.windows2universe.org
- **The Phases of the Moon** by Noreen Grice**; Oreo cookie moon phases** by Chuck Bueter (for younger children)**; Moon Finder activity with paper plates** by Chuck Bueter**; and Paper Moons – moon phases book from paper plates** by Sharon Mendonsa**,** all at http://analyzer.depaul.edu/paperplate

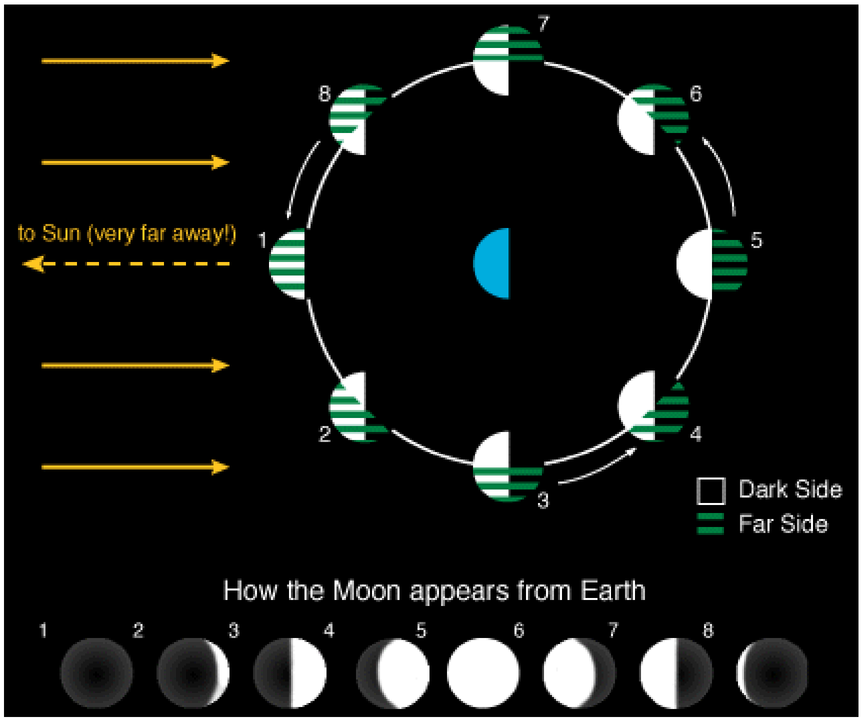
Vocabulary

Phases: Stages that the Moon goes through, in which the amount of the lit half of the Moon that we can see changes.
Waxing: When the lit part of the Moon is getting bigger each day (from New to Full). The term comes from dipping candles in wax (they get bigger with each dip.)
Waning: When the lit part of the Moon is getting smaller each day (from Full to New).

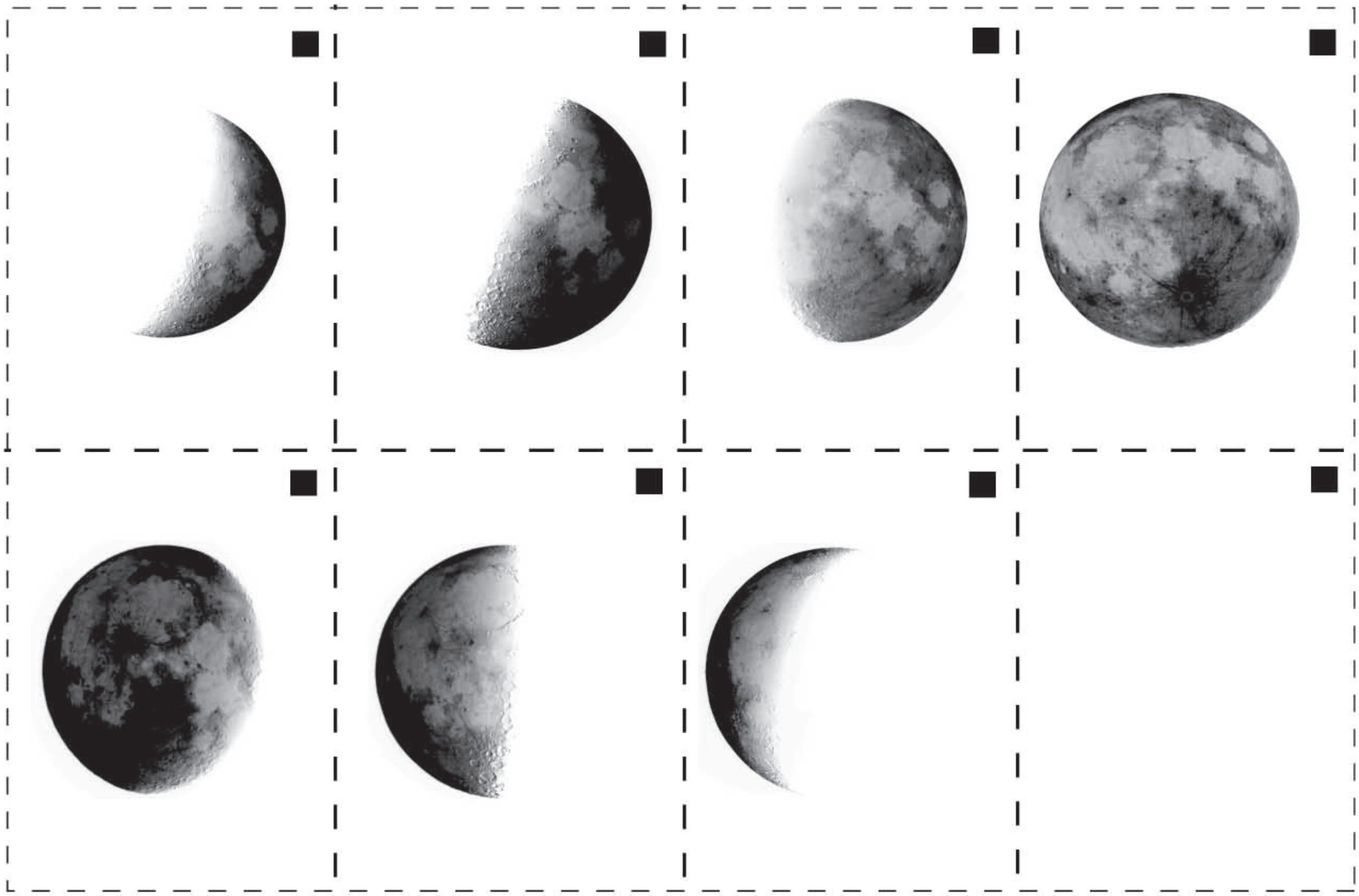
Astronomy I
Moon Phases

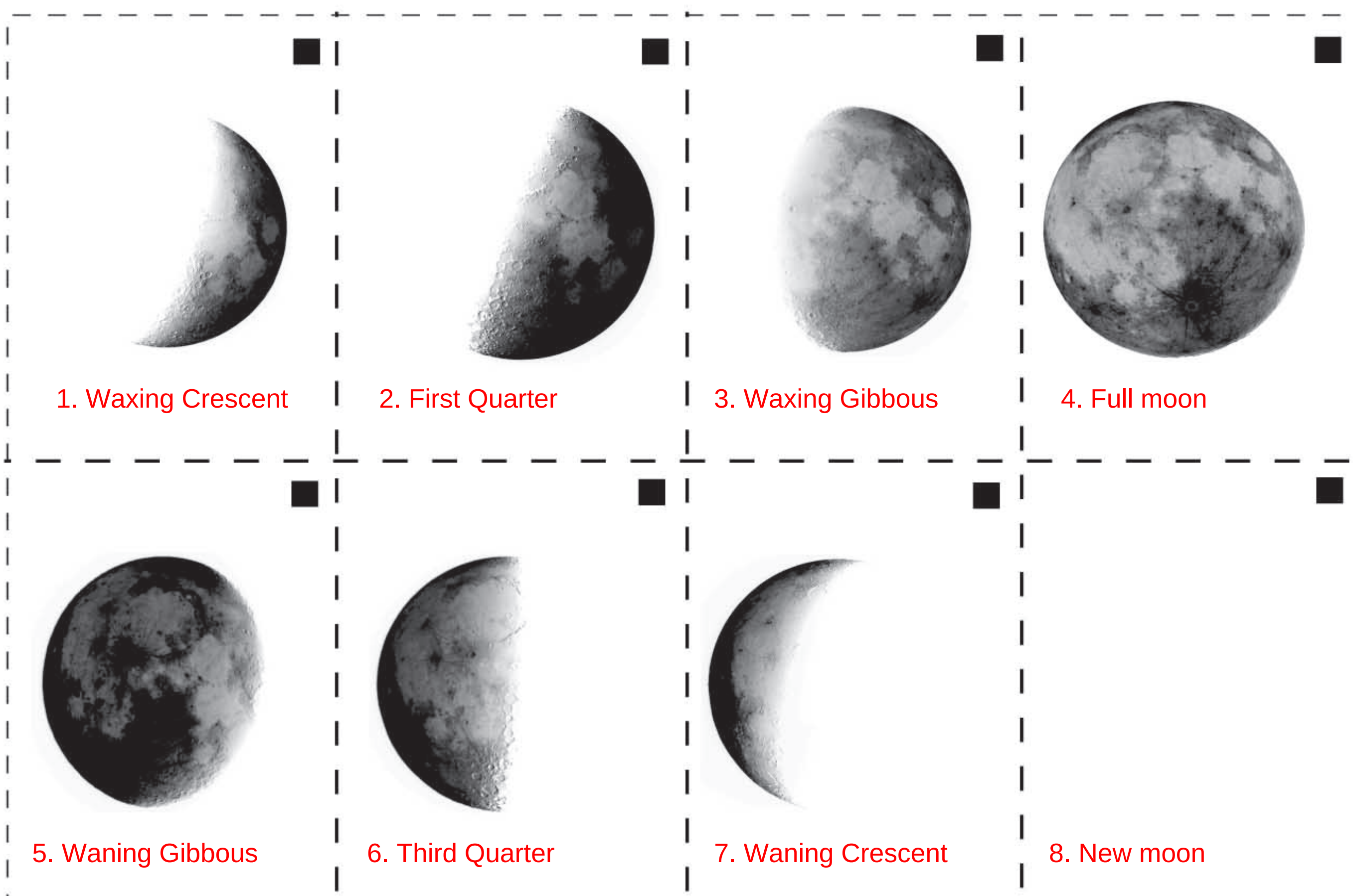
Background Resources

The cause of Moon phases is a difficult concept that won't be truly understood by many younger children. It is enough for younger children to observe that the moon changes in the sky and to be introduced to the idea that it is because of changes in the position of the Earth, Moon and Sun. The Earth rotates and orbits the Sun. The Moon orbits the Earth.

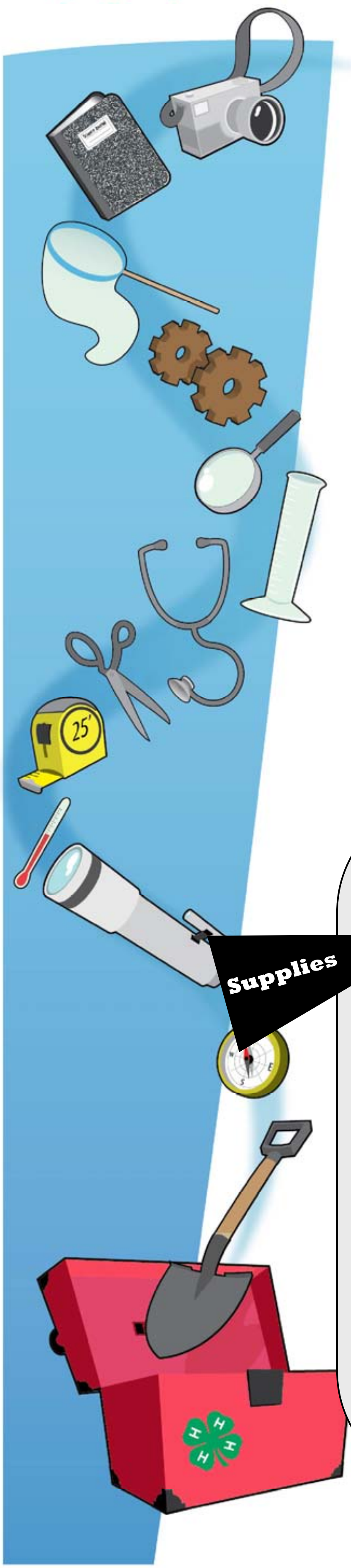


This image is from Windows to the Universe (http://windows2universe.org) 2010, National Earth Science Teachers Association. This work is licensed under a Creative Commons Attribution-ShareAlike 3.0 Unported License.





This image is from http://analyzer.depaul.edu/SEE_Project/MoonPhases/MoonPhases.htm from The Phases of the Moon by Noreen Grice. Images by Vivian Hoette at Yerkes Observatory.



Astronomy 1: Sky Gazing

Mystery Shadows: Solar and Lunar Eclipses

Activity Series:: Astronomy 1
Grade: 3rd & up
Time: 45-60 min

Main Idea

An eclipse is an astronomical event that occurs when one celestial object moves into the shadow of another. As the moon rotates around the Earth, sometimes its shadow hits the Earth, causing a solar eclipse. Also, sometimes the Earth's shadow falls across the moon causing a lunar eclipse (only during a full moon). Eclipses occur when the Sun, Earth and moon are in a straight line, which doesn't happen every month because the moon's orbit is tilted in relation to the Earth's orbit around the Sun.

Motivator

A lunar eclipse (luna is the Latin name for Earth's moon) is one of the most beautiful events that can be viewed in the sky. The sun, however, can never be viewed directly, even during a solar eclipse. But there are other methods of observing a solar eclipse. Eclipses of the Sun and moon have always left a deep impression on people. The loss of the Sun, which Ancient people called the "bringer of life," was considered a bad omen. For centuries, people feared solar eclipses. Today some people travel around the world to view one.

Pre-Activity Questions

Before you start the activity, ask the students:

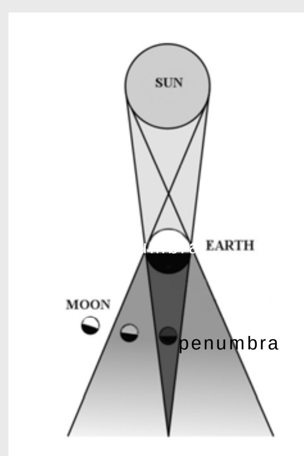
- Have you ever seen a lunar or solar eclipse or pictures of one?
- Do you know what causes eclipses?
- Do you know the difference between a solar and a lunar eclipse?

Let's see if we can figure it out by experimenting with models.

Activity 1: Lunar Eclipse

Supplies

- Ping pong ball
- Hula-hoop (or large quilting hoop)
- Lamp without a shade (or clamp lamp)
- Dark room
- Tape



1. Set up the lamp at the level of the participants' heads.
2. Tape the ping pong ball (representing the moon) to the hula-hoop so it sticks up from the edge. The ping pong ball represents the moon.
3. Have a student hold the hula-hoop around his/her head (which represents the Earth) at a slight tilt, about 5%. Darken the room.
4. The student representing Earth should orbit in a slow counter-clockwise circle around the lamp, while revolving the hula-hoop around his/her head counterclockwise to model the moon's orbit

Objectives

- To learn how and why solar and lunar eclipses occur.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

Contributed By

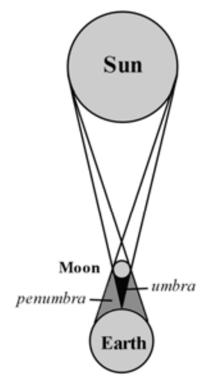
Nancy Schaff, Cornell Center for Radiophysics & Space Research in the Department of Astronomy

around the Earth and the Earth's orbit around the Sun. Try it first without orbiting the Sun.

5. Watch for a point where the moon (the ping pong ball) is on the opposite side of the Sun and in a line with the Earth and Sun. The moon will pass into the Earth's shadow and a lunar eclipse will occur.
6. Let other participants play the role of Earth.

Activity 2: Solar Eclipse

1. Follow the same procedure as described in Activity 1.
2. But now watch for a point where the moon (the ping pong ball) is between the Earth and Sun and in a line with the Earth and Sun. The moon's shadow will pass across the Earth and block the light from the Sun on a small part of the Earth, causing a solar eclipse.



Science Checkup - Questions to ask to evaluate what was learned

You may want to go back to the models to try to answer these. (See background resources for answers.)

- ❑ Which type of eclipse is visible to more people on Earth?
- ❑ What phase does the moon need to be in for a lunar eclipse to occur?
- ❑ What phase does the moon need to be in for a solar eclipse to occur?
- ❑ Why doesn't a solar or lunar eclipse happen every time that the moon is at full or new phase?

Extensions

- Check out the NASA eclipse site: http://eclipse.gsfc.nasa.gov/eclipse.html
- Look up the date and time of the next lunar eclipse and try to observe it.
- Check out the "Windows to the Universe" lunar and solar eclipse pages: www.windows2universe.org

Astronomy 1

Solar and Lunar Eclipses

Vocabulary

Lunar eclipse: A darkening of the moon, as viewed from Earth, caused when our planet passes between the Sun and the moon.
Solar eclipse: A phenomenon in which the moon's disk passes in front of the Sun, blocking sunlight. A total eclipse occurs when the moon completely obscures the Sun's disk, leaving only the solar corona visible.
Umbra and Penumbra: The Earth's shadow is broken up into two parts. The umbra is the darker part of the shadow where no part of the Sun can be seen. The penumbra is lighter than the umbra, because part of the Sun can be seen. During a lunar eclipse, when part of the moon passes through the umbra, this is called a partial eclipse. When the entire moon passes through the umbra, this is called a total eclipse. When the moon only passes through the penumbra, this is called a penumbral eclipse.

Background Resources

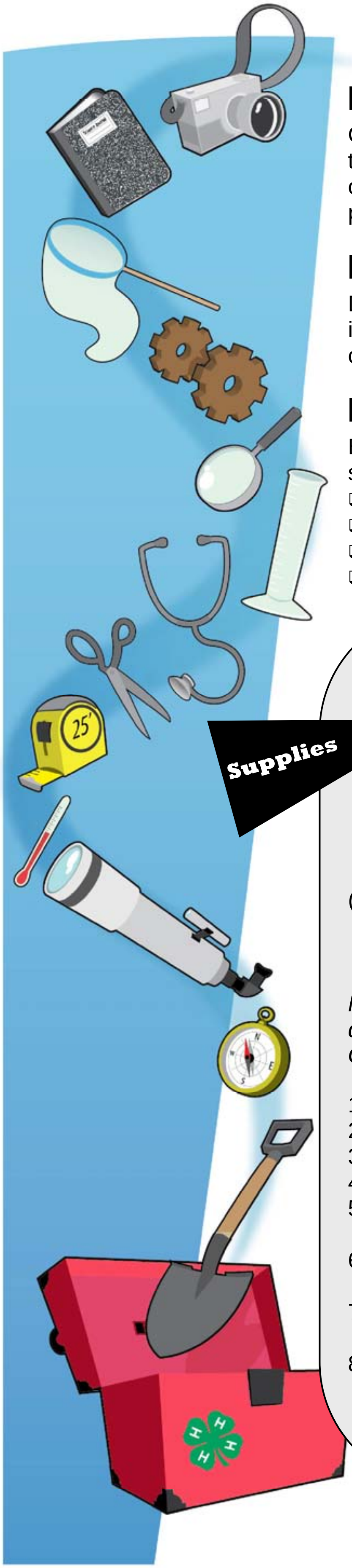
- Because the Earth's shadow is larger than the Moon's shadow, a lunar eclipse is visible to everyone on the night side of Earth.
- An eclipse of the Moon (or lunar eclipse) can *only* occur at Full Moon, and only if the Moon passes through some portion of Earth's shadow.
- An eclipse of the Sun (or solar eclipse) can *only* occur at New Moon when the Moon passes between the Earth and the Sun. If the Moon's shadow happens to fall upon the Earth's surface at that time, we see some portion of the Sun's disk covered or "eclipsed" by the Moon.
- Since a New Moon occurs every 29 and 1/2 days, you might think that we should have a solar eclipse about once a month. This doesn't happen because the Moon's orbit around Earth is titled five degrees to the plane of Earth's orbit around the Sun. As a result, the Moon's shadow usually misses Earth as it passes above or below our planet at New Moon. At least twice a year, the geometry lines up just right so that some part of the Moon's shadow falls on Earth's surface and an eclipse of the Sun is seen from that region of Earth. Remind your students of the slightly tilted hula-hoop — this represents the five-degree tilt of the Moon's orbit.

4-H Science Toolkit

Astronomy 1: Sky Gazing

What Time is It? Make a Sundial

Activity Series: Astronomy 1
Grade: 3rd & up
Time: 1 hour



Main Idea

Our concept of time is based on the motion of the Sun. Sundials work on the simple principle that as the sun moves through the sky, the gnomon, or centerpiece pointer, casts a moving shadow on the dial to indicate the passage of time.

Motivator

Did you know that ancient people could tell the time of day just by looking at the sun's position in the sky? You can make a simple instrument called a sundial to help you tell time without a watch.

Pre-Activity Questions

Before you start the activity, ask the students: (See background resources for answers)

- ❑ Where is the sun at noon?
- ❑ How long is a day?
- ❑ Does the number of hours of daylight change during the year? (yes)
- ❑ Do you know how to find the North Star (Polaris) in the sky?

Activity

Supplies

- ❑ Copies of the sundial design on cardstock (one for each student)*
- ❑ Scissors
- ❑ Tape
- ❑ Crayons or markers
- ❑ The latitude at which you live

(see http://jan.ucc.nau.edu/~cvm/latlon_find_location.html)

- ❑ Blocks of wood or stones (optional)
- ❑ Compass to find north

*Note: * If you don't have access to cardstock, you can print out the sundial and have the kids bring in empty cereal boxes or other cardboard. Glue the design to the box, then cut through both layers.*

1. Cut out the base of the sundial and the sundial's gnomon.
2. Color the sundial if desired.
3. Cut the centerline on the base of the sundial.
4. Fold the tabs on the base down and tape them to each other.
5. Cut the gnomon to the approximate degree of latitude for your location.
6. Slide the gnomon up through the center slit in the base and fold the tabs against the bottom of the sundial and tape them there.
7. Glue the sundial to a block of wood or use stones to keep from blowing away (optional).
8. Bring the sundial outside, and point the number 12 toward North.

*Remember, during daylight savings time you must **ADD** one hour to the time.*

Objective

- To build a paper sundial that can be used at home.
- To learn how to tell time using a sundial.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

Contributed By

Nancy Schaff,
Cornell Center for Radiophysics & Space Research in the Department of Astronomy

4-H Science Toolkit

Astronomy 1
What Time is It? Make a Sundial

Science Checkup - Questions to ask to evaluate what was learned

- ❑ Why do you think you add one hour to the sundial's time during daylight savings time?
- ❑ What would happen if you had the gnomon pointing south instead of north?
- ❑ Why is it important to cut the gnomon to a particular angle correlating to the correct latitude?

Do some research and experimentation if you need to!

Extensions

To learn more about sundials check out these sites:

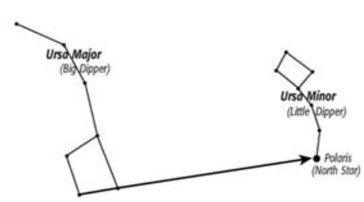
- http://www.sundials.org
- http://www.phy6.org/stargaze/Sundial.htm
- *Sky Tellers* "Day and Night" and "Polaris" activities at http://www.lpi.usra.edu/education/skytellers/day_night/
- Making a pocket sun clock from the Pacific Science Center: www.pacsci.org/download/astro_ad_sun_clock.pdf

Vocabulary

Gnomon: The centerpiece of a sundial, which stands at a particular angle that correlates to a specific latitude, in order to cast the appropriate shadow onto a sundial.
Lines of Latitude: Imaginary lines that run parallel to the equator that tell a point's location north or south of the equator.

Background Resources

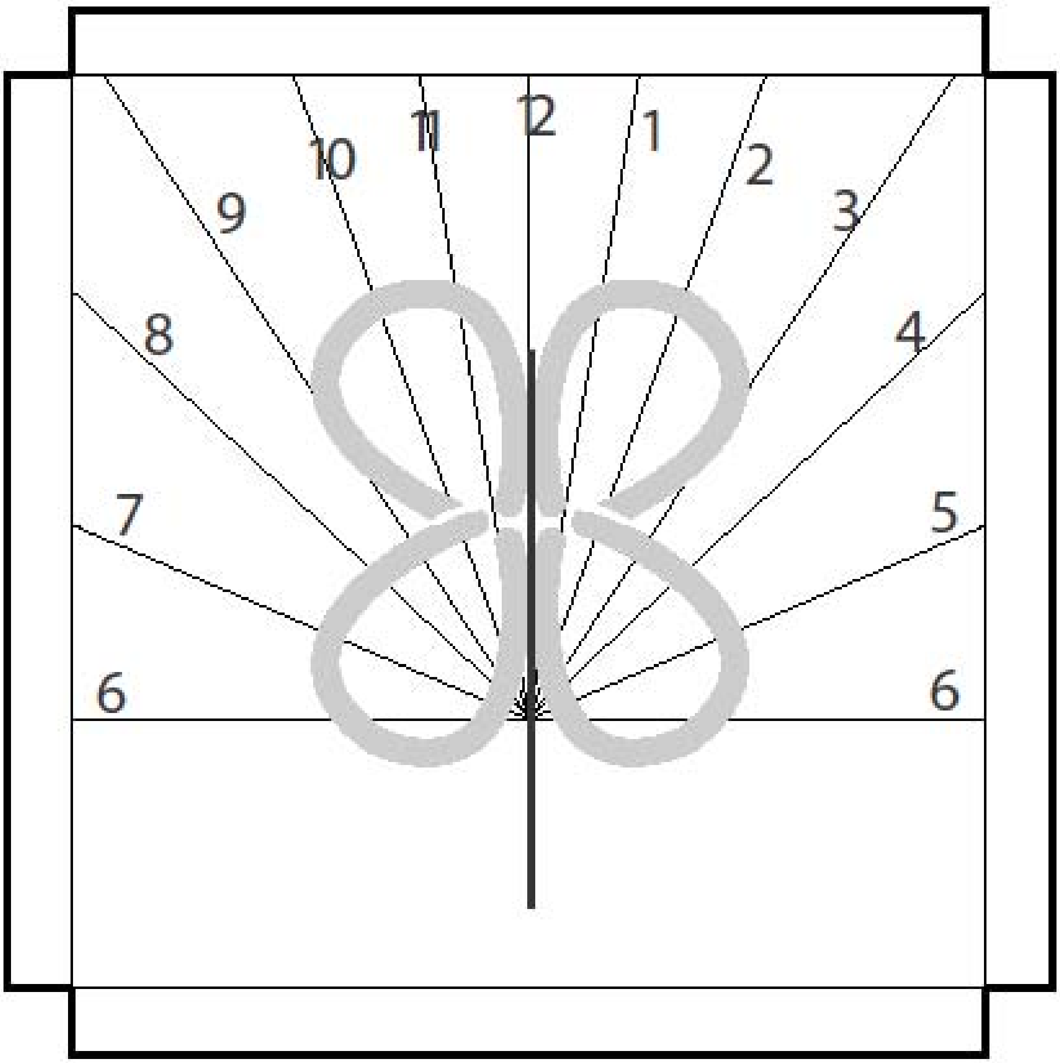
- Sundials are the oldest time-measuring devices and may be the earliest scientific instruments. The earliest sundials known from the archaeological record are obelisks (3500 BC) and shadow clocks (1500 BC) from ancient Egypt and Babylon. Sundials are believed to have existed in China since ancient times, but very little is known of their history. Sundials were also used in ancient Greece and Rome. In central Europe, sundials were the most common method to determine time, even after the mechanical clock was developed in the 14th century. The sundial was actually used to check and adjust the time on mechanical clocks until late into the 19th century. Sundials come in all shapes and sizes, from tiny pocket dials to huge dials in observatories or parks. Although their main purpose is to tell the time, they are often used as focal points in gardens, as art in the form of sculptures and even as jewelry.
- To find the North Star (Polaris), find the Big Dipper (part of the constellation Ursa Major) in the sky. While looking at the Big Dipper go to the two stars that make up the end of the bowl. Follow the line that these two stars make until you reach the next bright star (but not nearly the brightest star in the sky). This star is the North Star (Polaris). Polaris is the end of the handle of the Little Dipper (Ursa Minor).



- At noon, the sun is approximately south but not directly overhead (as many people think.) For most locations, local solar noon does not occur at exactly 12 noon because time zones cover a great distance east to west (and daylight savings time will also affect the actual time).
- Our 24-hour day is actually a solar day, which is the time it takes for the Sun to make one circuit around the local sky. We think of a day as the length of time it takes for the Earth to rotate once, but that is actually about 4 minutes less than 24 hours. A solar day is just a bit longer because the Earth is orbiting the Sun at the same time it is rotating.

Worksheet 8.1

Sundial Base

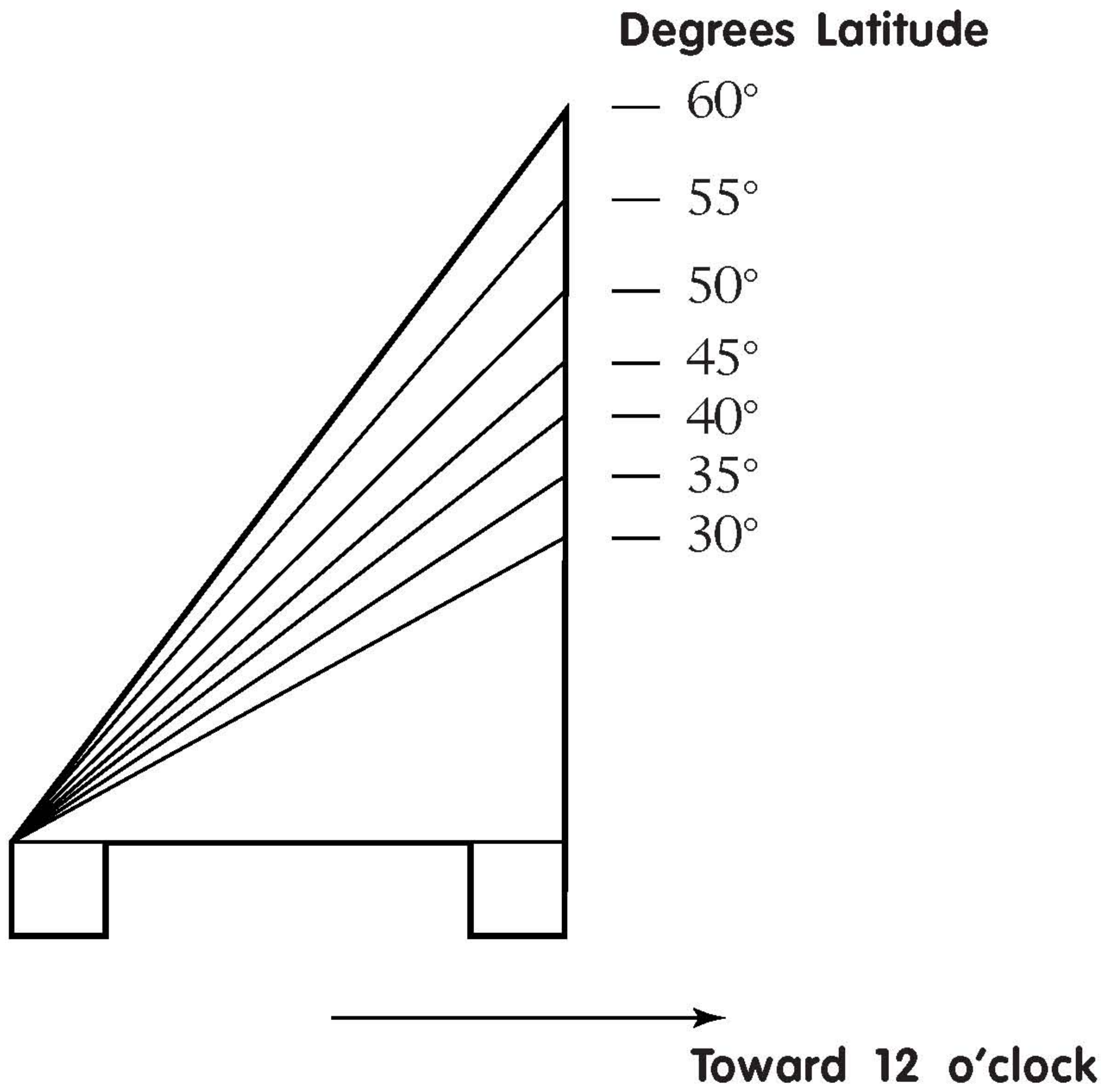


Instructions

1. Cut out around black lines.
2. Fold tabs down.
3. Place gnomon along black line in center of sundial.

Worksheet 8.2

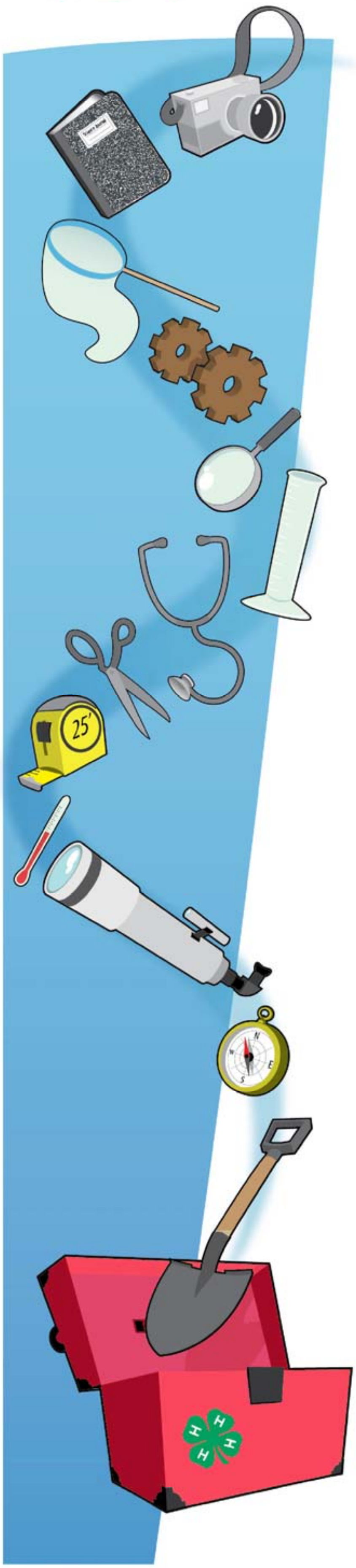
Sundial Gnomon



Instructions

1. Cut out along dark black lines.
2. Cut the line at the correct latitude.

4-H Science Toolkit



Astronomy 1:

Sky Gazing

Appendix:

Leader supplemental resources to use with "Making a Star Chart"

1. Mythology of the Constellations — background information
2. List of 88 constellations recognized by the International Astronomical Union
3. Activities to help participants locate constellations in the sky without a sky map
   a. Connecting the Dippers
   b. Arcing Along
   c. Summer Triangle
4. Crossword Puzzle Answer Sheet

Mythology of the Constellations

References: Worksheet 1.3 Constellation Matching
Worksheet 1.4 Mythology Crossword Puzzle

Scorpion

Of the 88 constellations, most were named by the ancient Greeks and Romans. The ancient people made up stories to explain natural occurrences that they did not understand. Many of these stories were related to the forms of the constellations in the skies and are what we now call mythology.

One story told in the constellations is the same story told in the movie *Clash of the Titans.* Using your star chart, find the constellations Andromeda, Perseus, Cassiopeia, Pegasus, and Cepheus. These figures play out part of the story.

In the story, Cassiopeia the queen and her husband Cepheus the king had a very beautiful daughter, Andromeda. They claimed their daughter was more beautiful than the sea nymphs, who were considered the most beautiful creatures on the earth. Poseidon, the Sea King, became so angry with Cassiopeia and Cepheus' claim that he sent a sea monster to destroy the kingdom unless they sacrificed Andromeda to the sea monster. Meanwhile, Perseus, a brave knight, had been on a quest and had killed the Medusa, which when looked at could turn the viewer to stone. Perseus arrives on his flying horse Pegasus, jumps off, and uses the head of the Medusa to turn the sea monster into stone and thus save Andromeda.

Poseidon

Other stories use fewer constellations but are just as exciting. The tale of Orion and the Scorpion is a simple story. Orion was a great hunter and claimed that he could defeat any animal. This angered the goddess Juno, and she sent a scorpion to kill Orion. The moon goddess Diana felt sorry for Orion after his death and put him in the stars, along with the Scorpion—but the Scorpion is on the opposite side of the sky where it can never bother Orion again!

Diana

List of the Constellations

Constellations are figures and patterns that are overlaid on the stars to form pictures. These are the 88 constellations recognized by the International Astronomical Union since 1933.

Andromeda	The Princess
Antlia	Air Pump
Apus	Bird of Paradise
Aquarius	Water Carrier
Aquila	Eagle
Ara	Altar
Aries	Ram
Auriga	Charioteer
Boötes	Herdsman
Caelum	Graver's Tools
Camelopardalus	Giraffe
Cancer	Crab
Canes Venatici	Hunting Dogs
Canis Major	Greater Dog
Canis Minor	Lesser Dog
Capricornus	Horned Goat
Carina	Keel
Cassiopeia	Queen (Lady in the Chair)
Centaurus	Centaur
Cepheus	King (Monarch)
Cetus	Sea Monster (Whale)
Chamaeleon	Chameleon
Circinus	Pair of Compasses
Columba	Noah's Dove
Coma Berenices	Berenice's Hair
Corona Australis	Southern Crown
Corona Borealis	Northern Crown
Corvus	Crow
Crater	Cup
Crux	Southern Cross
Cygnus	Swan
Delphinus	Dolphin
Dorado	Dorado (Fish)
Draco	Dragon
Equuleus	Colt, Small Horse
Eridanus	River Po
Fornax	Furnace
Gemini	Twins
Grus	Crane
Hercules	Hercules
Horologium	Clock
Hydra	Water Monster
Hydrus	Water Snake
Indus	Indian
Lacerta	Lizard
Leo	Lion
Leo Minor	Smaller Lion
Lepus	Hare
Libra	Balance (Scale)
Lupus	Wolf
Lynx	Lynx
Lyra	Harp (Lyre)
Mensa	Table Mountain
Microscopium	Microscope
Monoceros	Unicorn
Musca	Fly
Norma	Square (and Rule)
Octans	Octant
Ophiuchus	Serpent Holder
Orion	Great Hunter
Pavo	Peacock
Pegasus	Winged Horse
Perseus	Hero, Champion
Phoenix	Fire Bird
Pictor	Painter's Easel
Pisces	Fishes
Pisces Austrinus	Southern Fish
Puppis	Stern
Pyxis	Mariner's Compass
Reticulum	Net
Sagitta	Arrow
Sagittarius	Archer
Scorpius	Scorpion
Sculptor	Sculptor's Workshop
Scutum	Shield
Serpens Caput	Serpent's Head
Serpens Cauda	Serpents Tail
Sextans	Sextant
Taurus	Bull
Telescopium	Telescope
Triangulum	Triangle
Triangulum Australe	Southern Triangle
Tucana	Toucan
Ursa Major	Larger Bear
Ursa Minor	Smaller Bear
Vela	Sails
Virgo	Maiden, Virgin
Volans	Flying Fish
Vulpecula	Little Fox

Activity: Connecting the Dippers

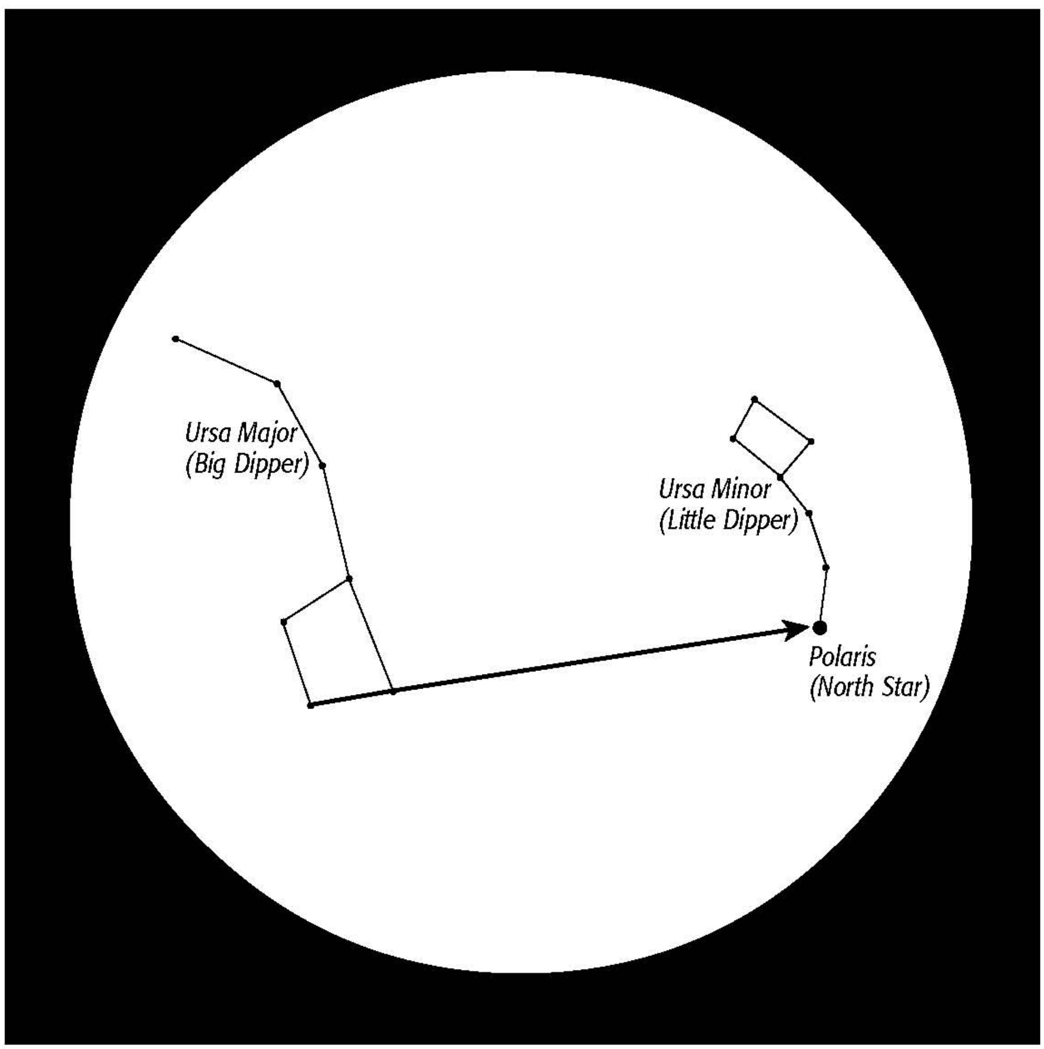
Reference: Worksheet 1.5 Connecting the Dippers

★ **Objective**
To locate the Little Dipper and the North Star using the Big Dipper

The Big Dipper is the most easily recognizable constellation in the night sky. From the Big Dipper many other constellations can be found. The first and most important to find are the Little Dipper and the North Star.

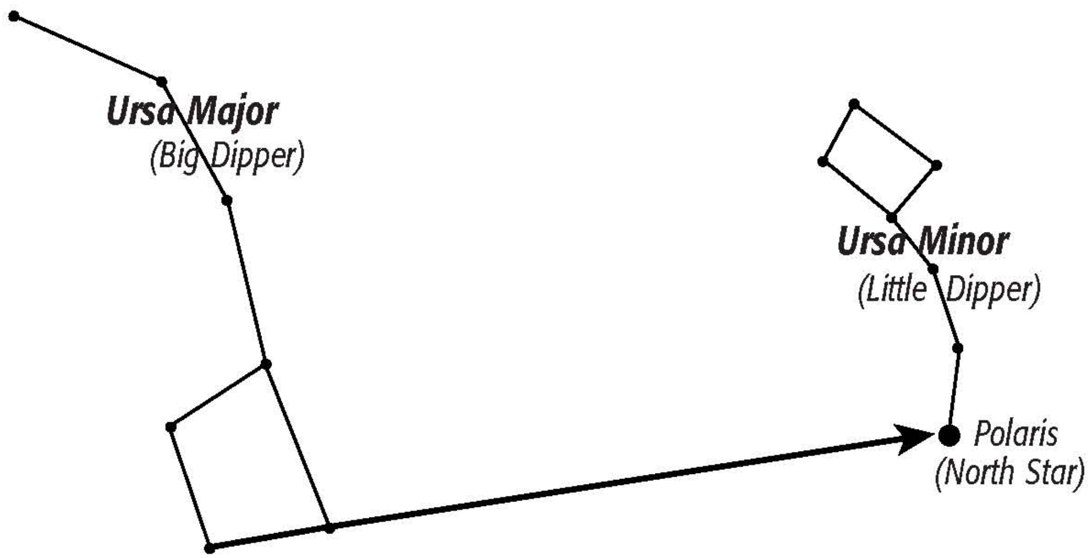
Procedure

1. While looking at the Big Dipper go to the two stars that make up the end of the bowl. Follow the line that these two stars make until you reach the next bright star. This star is the North Star, "Polaris." Polaris is not the brightest star in the sky, contrary to popular belief.
2. Polaris is the end of the handle of the Little Dipper. The Little Dipper is harder to see, and if there is much light pollution only the last two stars in the bowl will be visible.



Worksheet 1.5

Connecting the Dippers



Activity: Arcing Along

Reference: Worksheet 1.6 Arcing Along

★ **Objective**

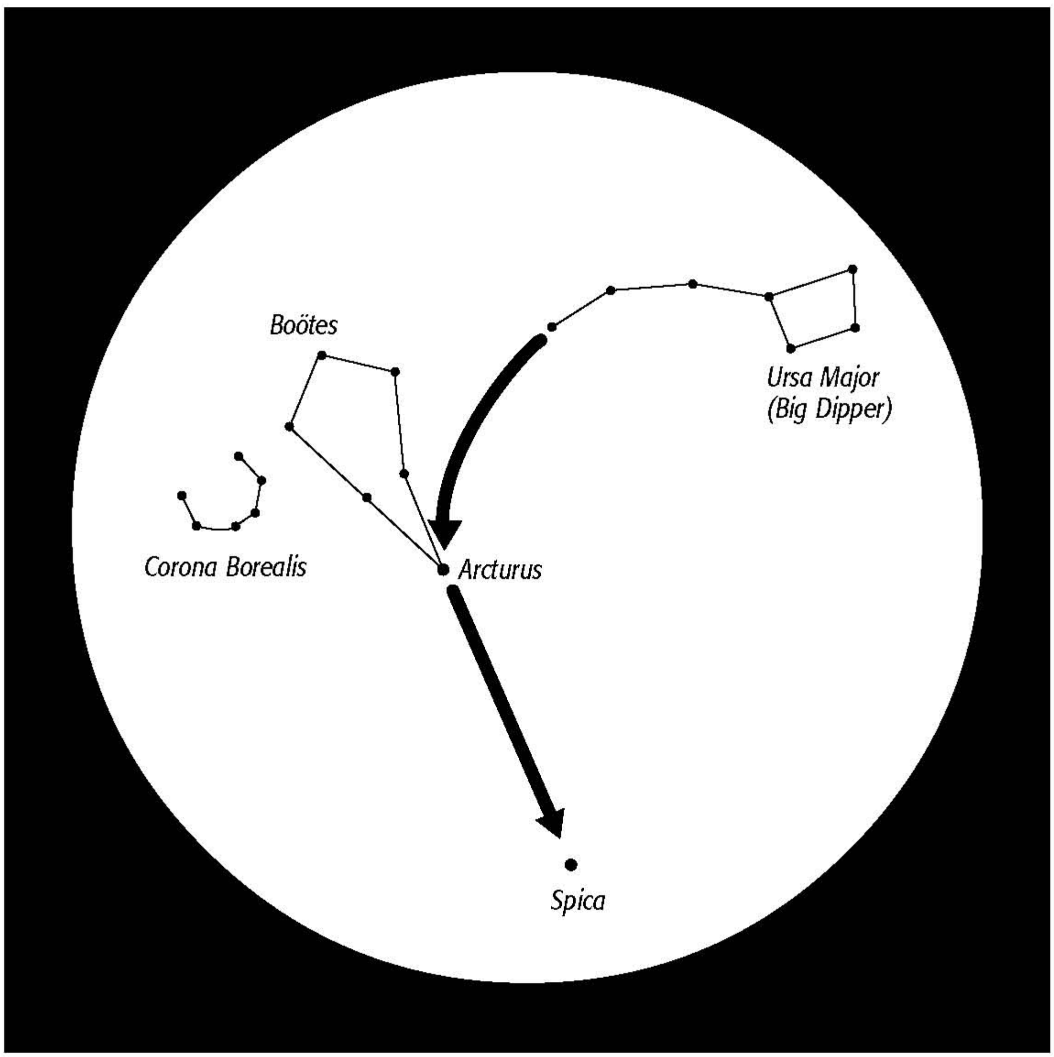
To locate other constellations using the Big Dipper

Again, we will be using the Big Dipper to point us to other constellations in the sky. Following the arc of the handle of the Big Dipper, go about the same distance away as the length of the handle, to the brightest star. This star is called Arcturus and is part of the constellation Boötes, which looks like an ice cream cone.

Procedure

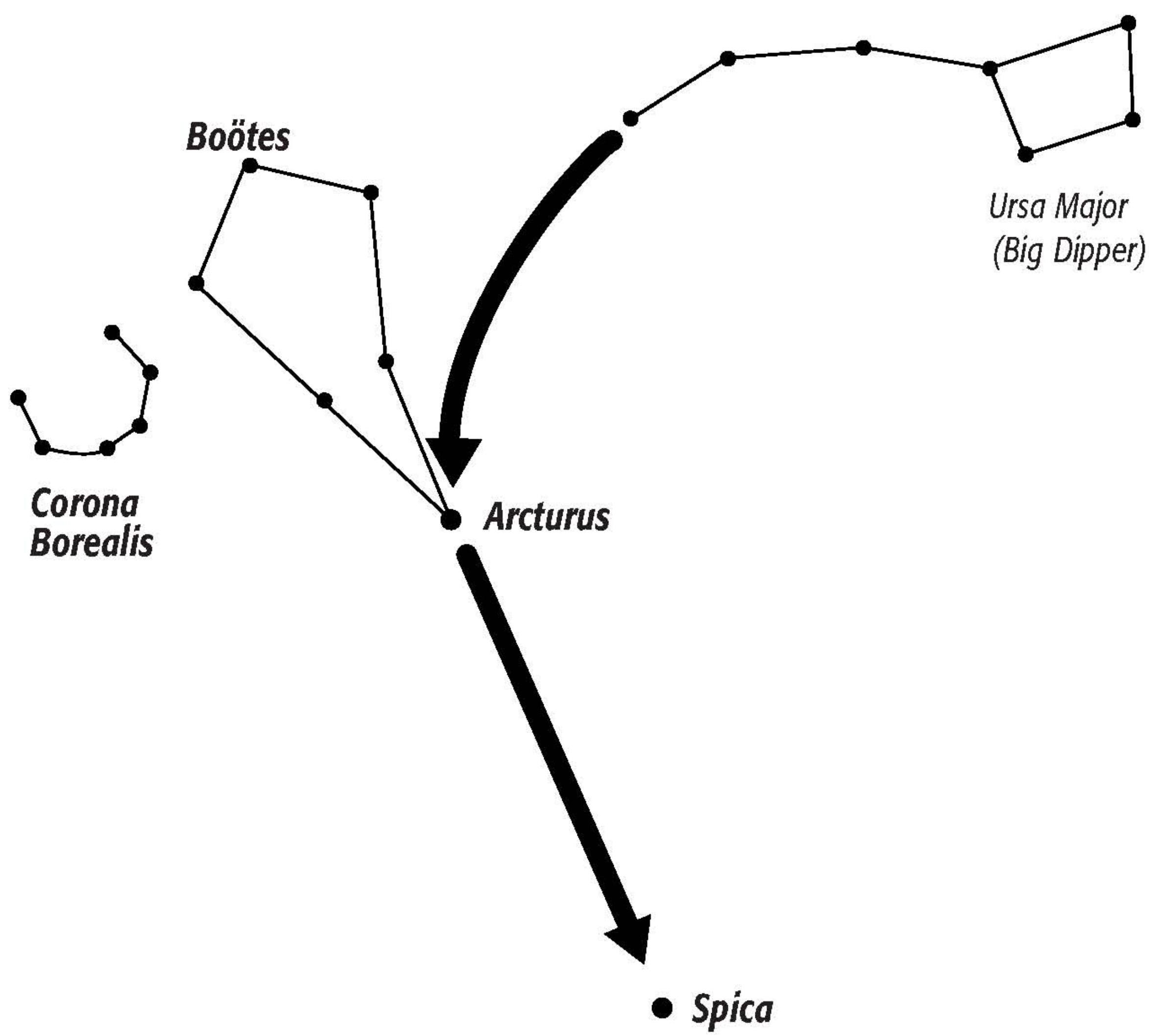
1. To the left of Boötes is a group of stars called Corona Borealis, the Northern Crown, but that looks more like a smile next to Boötes the ice cream cone.
2. From Arcturus, still following the arc of the dipper handle and going one more length is the star Spica.

So remember: From the Big Dipper, arc to Arcturus and speed to Spica.



Worksheet 1.6

Arcing Along



Activity: Summer Triangle

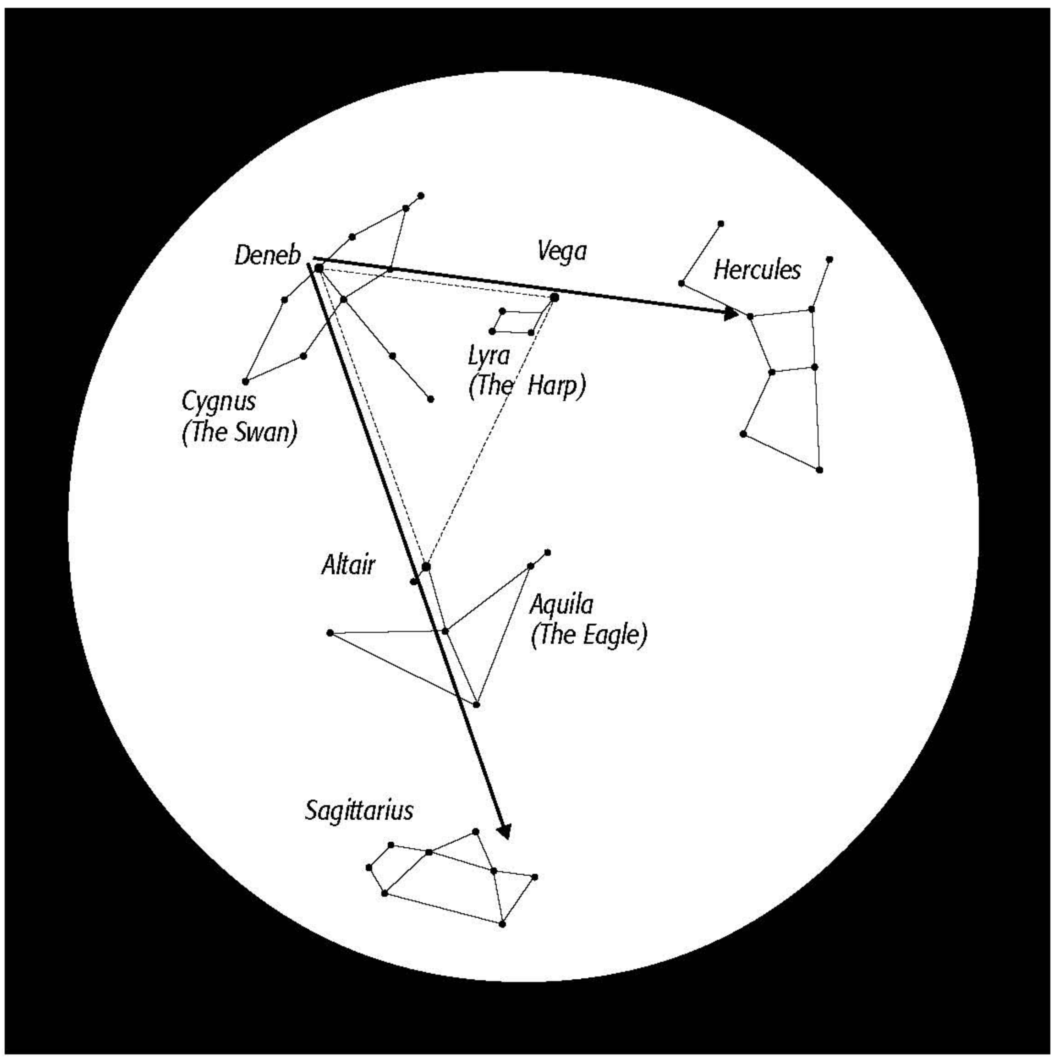
Reference: Worksheet 1.7 Summer Triangle

★ **Objective**
To locate the stars in the Summer Triangle

In the east in early summer and overhead in July and August is a very large constellation called the Summer Triangle. The triangle itself is not an official constellation, but its three corner stars are parts of different constellations.

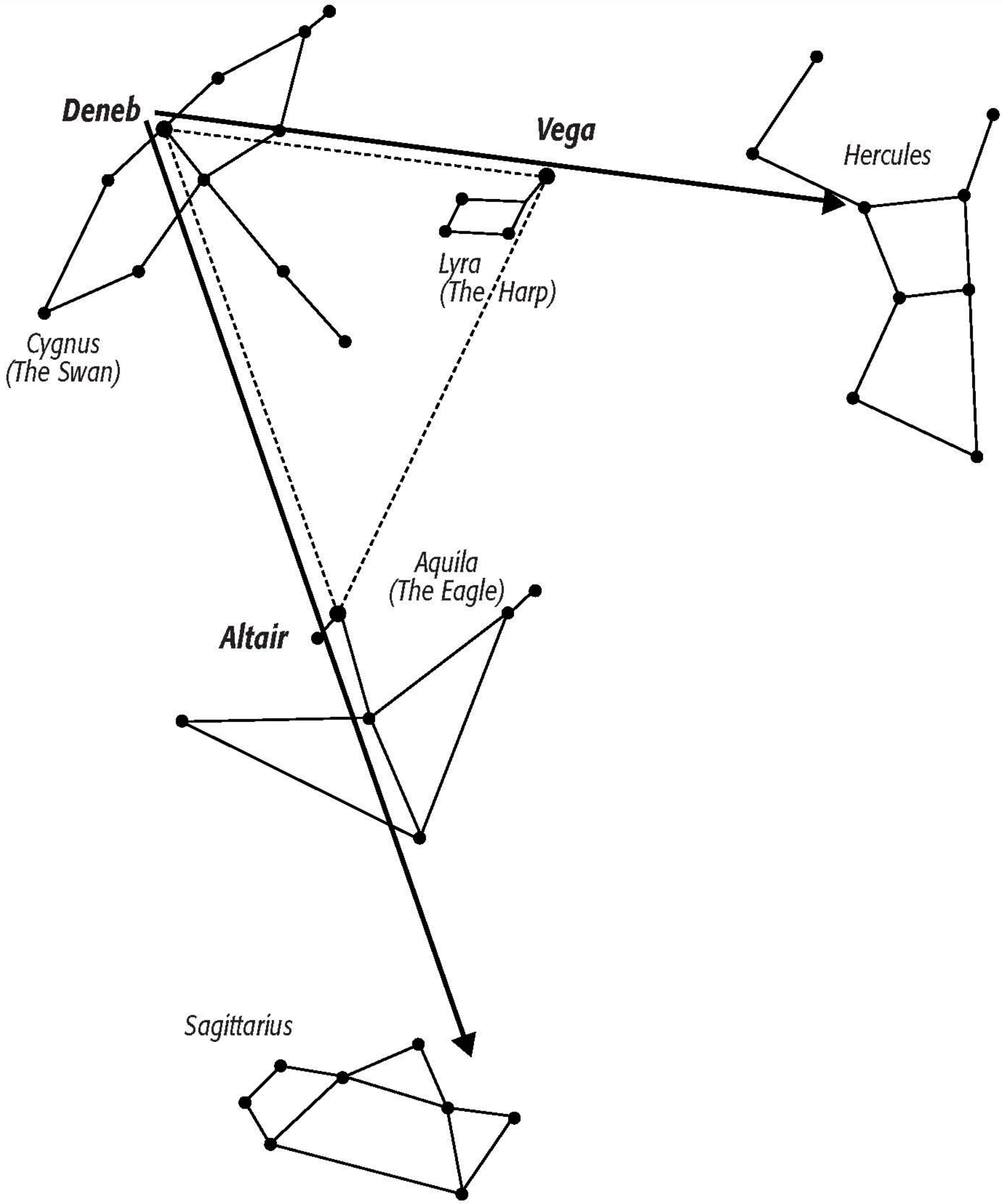
Procedure

1. The brightest star at the top or western side is called Vega, a star in the constellation Lyra the Harp. Going clockwise around the triangle, the next star is Altair, part of Aquila the Eagle. Next would be the star Deneb, part of the constellation Cygnus the Swan, or the Northern Cross.
2. By making a line between the stars of Deneb and Vega and following this line you will come to the constellation Hercules, which looks like a large trapezoid or keystone.
3. A line between Deneb and Altair brings you to the constellation Sagittarius. Sagittarius (the Archer) looks like a teapot and is low on the horizon.



Worksheet 1.7

Summer Triangle



Answer

		1 v																		
		i								2 c	a	n	i	s	m	i	n	o	r	
		r								a										
		g			3 h					n										
	4 b	o	o	t	e	s				c										
					r					e				5 c						
					c				6 u	r	s	a	m	a	j	o	r		7 p	
					u									s					e	
					8 l	y	r	a						s					g	
					e									i					a	
					9 s	c	10 o	r	p	i	u	s		o					s	
		11 t					r							12 p	e	r	s	e	u	s
		13 a	q	u	a	r	i	u	s					e					s	
		u					o					14 i		i						
		r				15 a	n	16 d	r	o	m	e	d	a						
		u						r				o								
		s						a												
								17 c	y	g	n	u	s							
								o												