A Cornell Cooperative Extension Publication

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Leader/Member Guide

by Brian Rice

Astronomy It's Out of This World

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Brian Rice, a ten-year member of Delaware County 4-H, was selected to write the material. He is now studying mechanical engineering technology at the University of Maine. Brian has work experience at the Maynard F. Jordan Planetarium at the University of Maine and taught astronomy at 4-H Camp Shankitunk in Delhi, New York. Appreciation for their help is expressed to Jay Sarton, head of the Kopernik Observatory at Binghamton, New York, Alan Davenport, director of Maynard F. Jordan Planetarium, and Albert Reed, former head of the Physics Department at SUNY College at Oneonta, New York.

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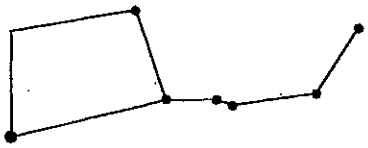
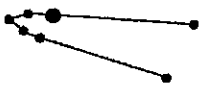
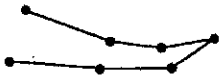
Worksheet 1.3

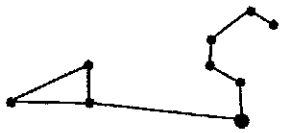
Constellation Matching

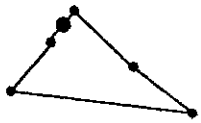


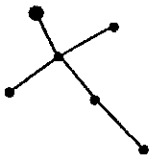


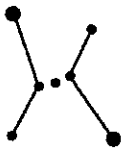


1. Aquila
2. Hercules
3. Corona Borealis
4. Ursa Major
5. Ursa Minor
6. Leo
7. Gemini
8. Boötes
9. Orion
10. Taurus
11. Pleiades
12. Cassiopeia
13. Andromeda
14. Pegasus
15. Cygnus
16. Lyra



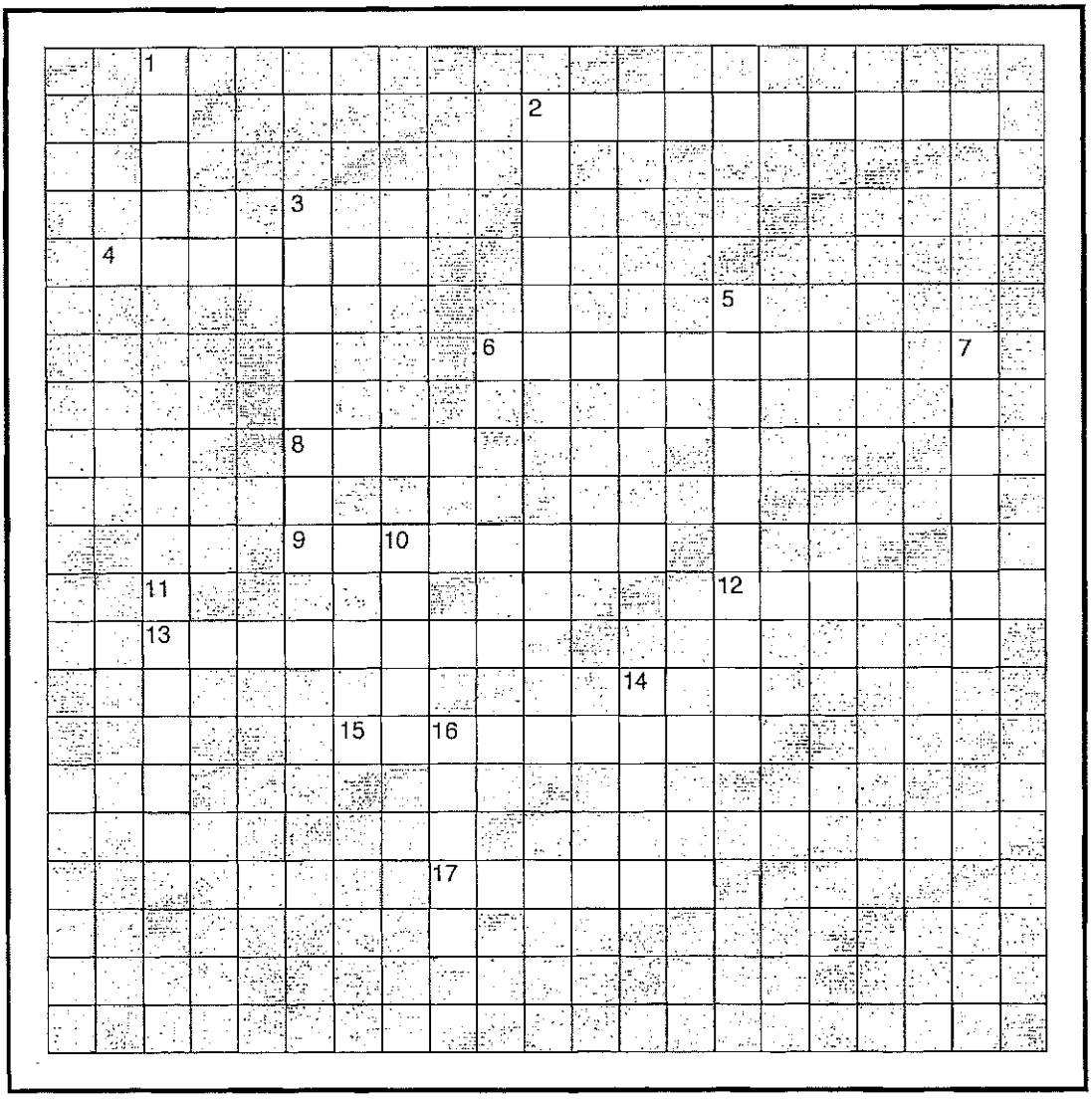






Worksheet 1.4

Mythology Crossword Puzzle



Clues

Across

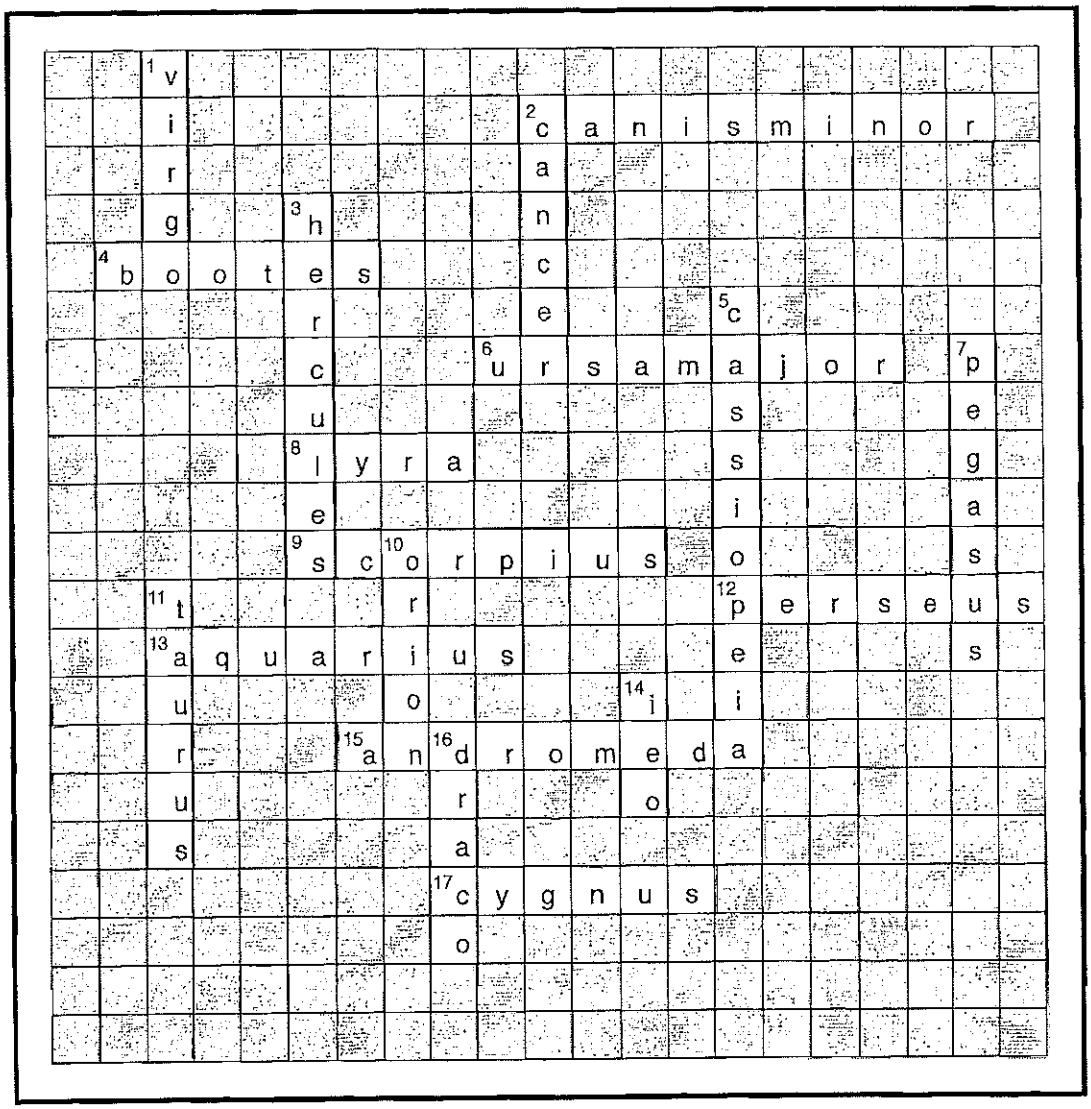
2 The Little Dog
4 The Shepherd
6 The Big Bear
8 The Harp
9 Killed Orion
12 Killed Medusa
13 The Water Bearer
15 Beautiful Princess Saved by Perseus
17 The Swan or The Northern Cross

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

Answer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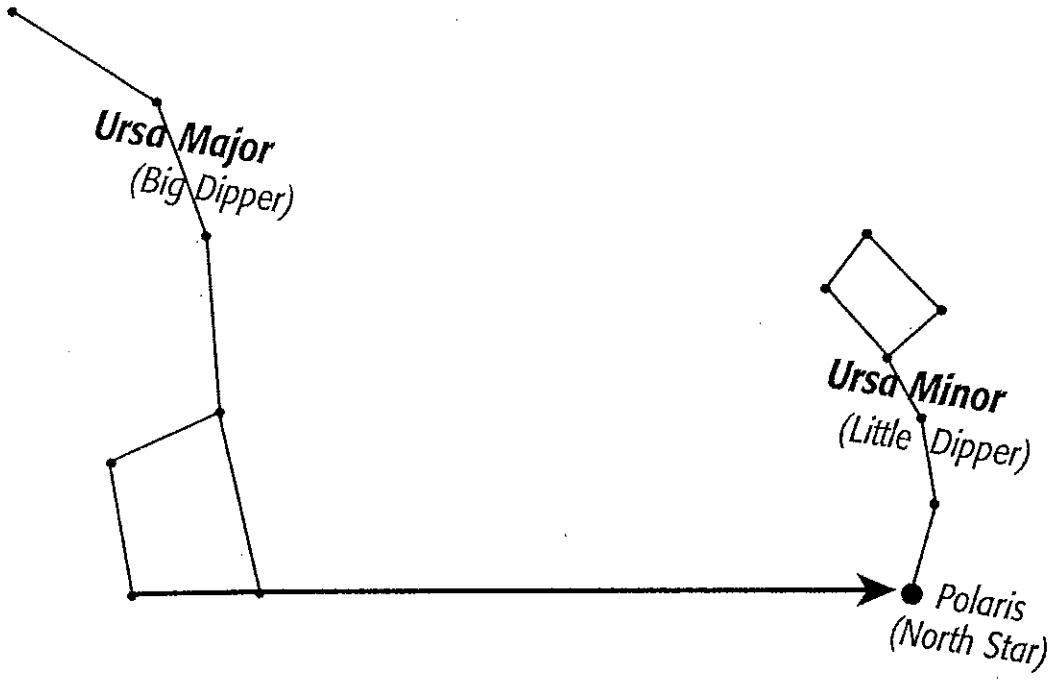
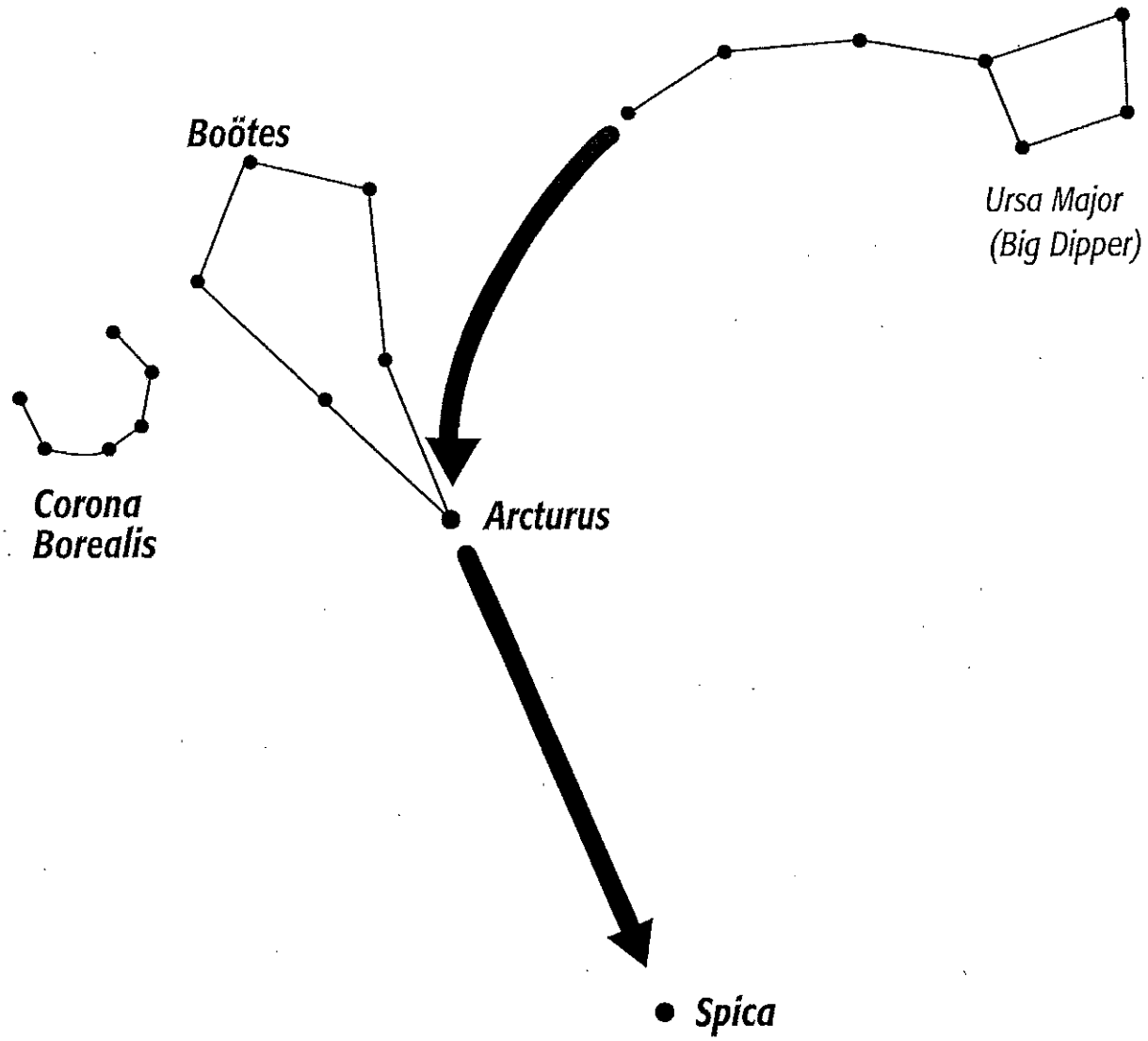
Worksheet 1.5

Connecting the Dippers



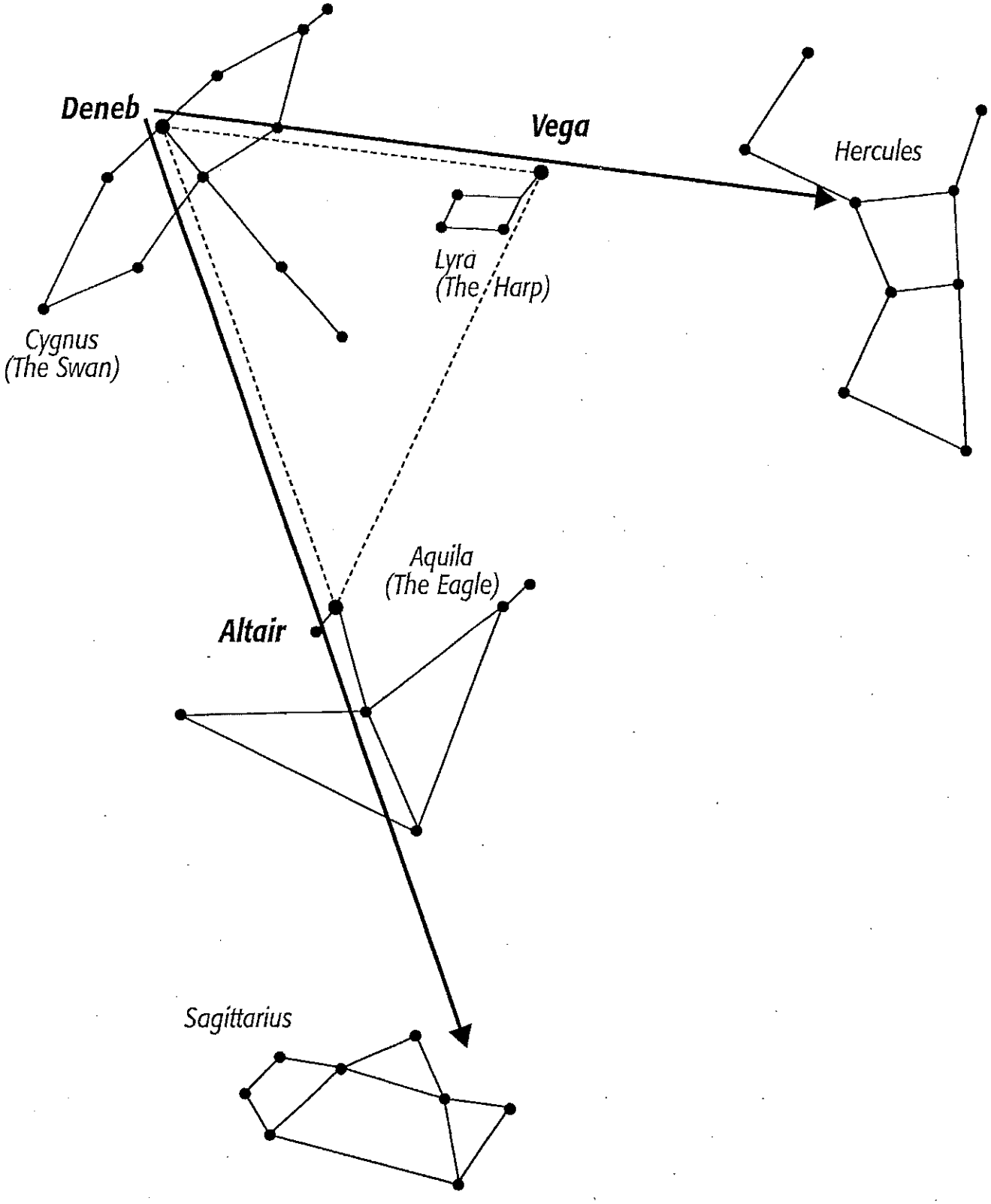
Worksheet 1.6

Arcing Along



Worksheet 1.7

Summer Triangle



Worksheet 4.1

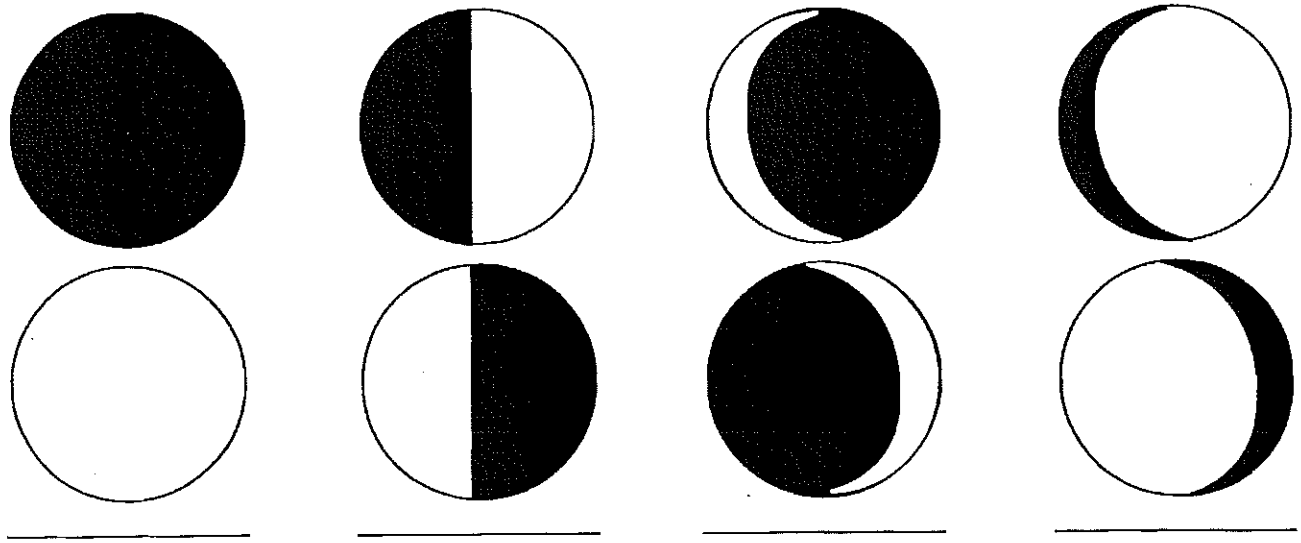
Cratering Worksheet

Object	Object Size	Height Dropped	Speed Dropped	Crater Size

Worksheet 4.2

Moon Phases

Label the phases of the moon and in what order they would appear in the sky.

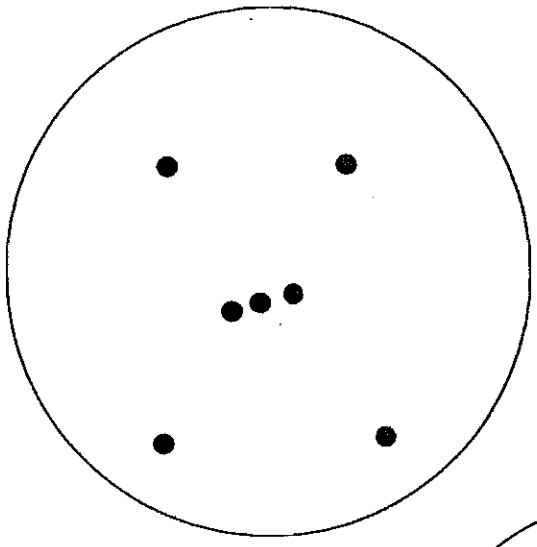


Phases of the Moon

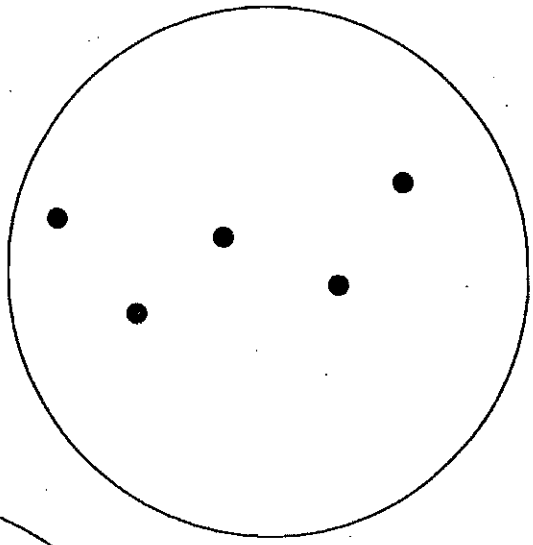
New Moon
Waxing Crescent
First Quarter
Waxing Gibbous
Full Moon
Waning Gibbous
Third Quarter
Waning Crescent

Worksheet 7.1

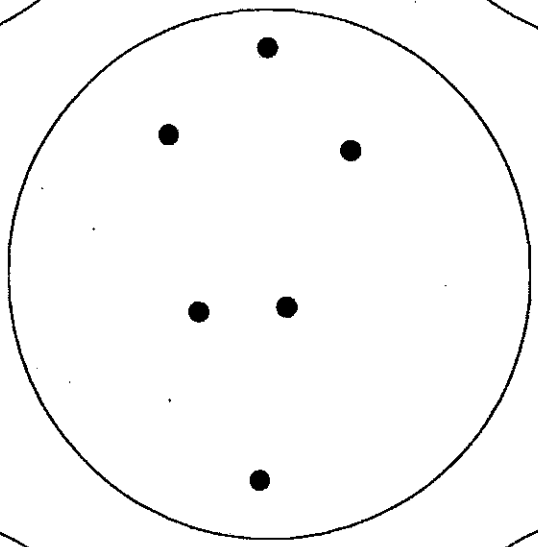
Constellation Patterns



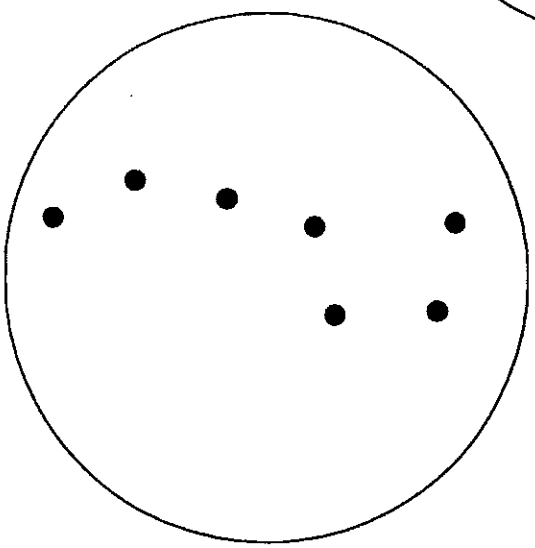
Orion



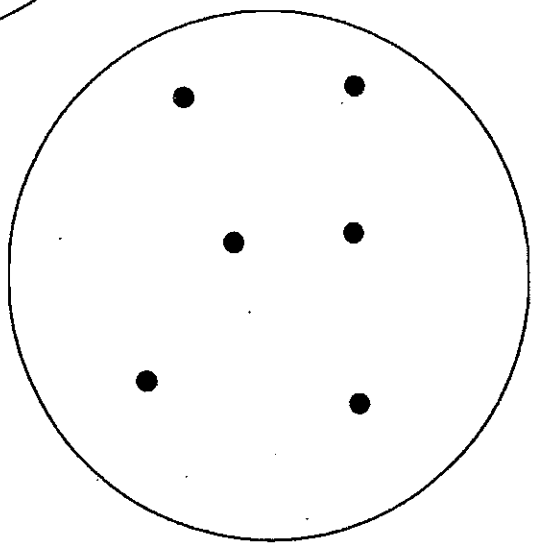
Cassiopeia



Boötes



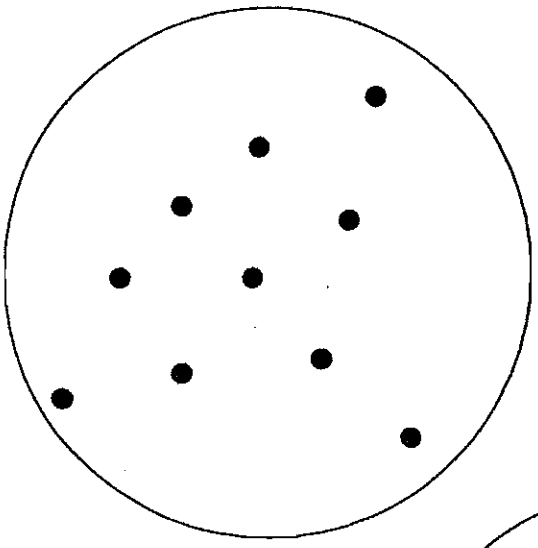
Ursa Major



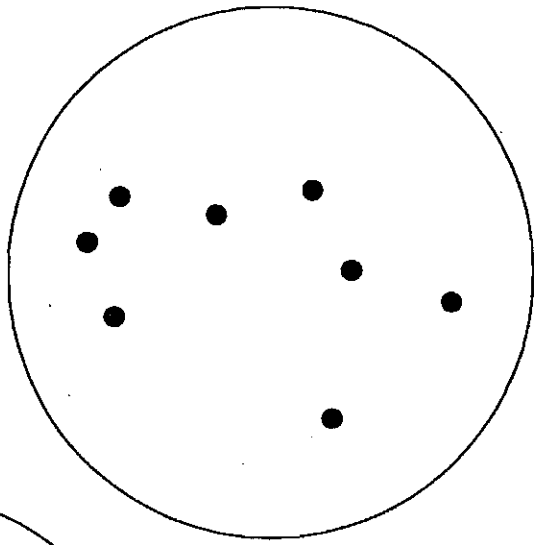
Hercules

Worksheet 7.2

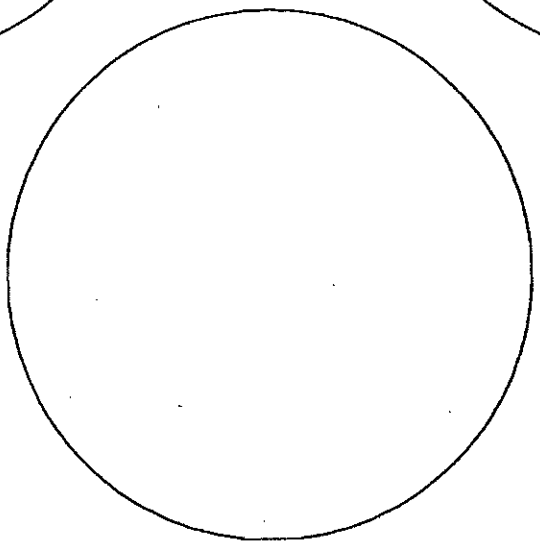
More Constellation Patterns



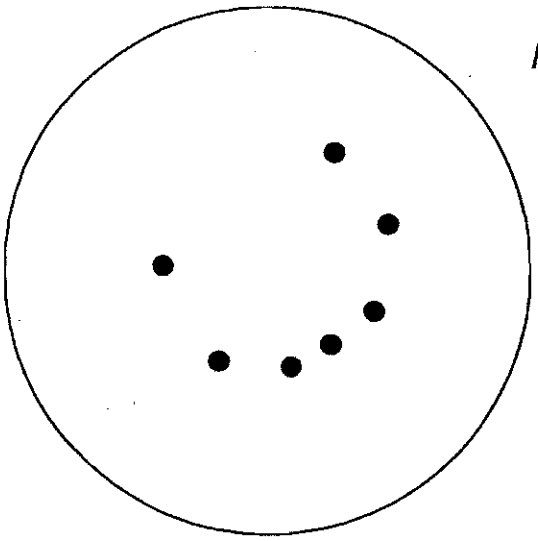
Cygnus



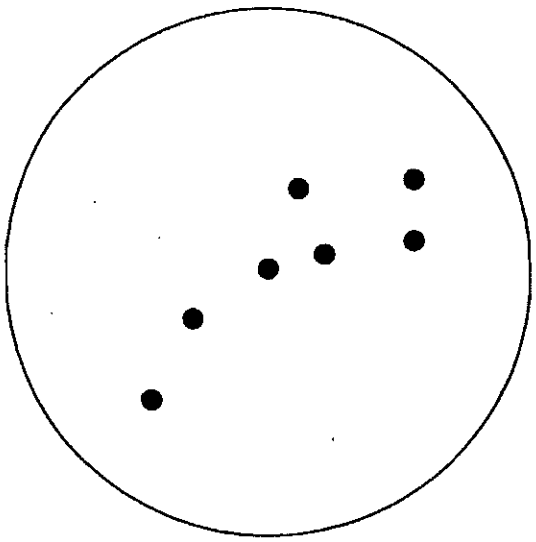
Sagittarius



Make Your Own



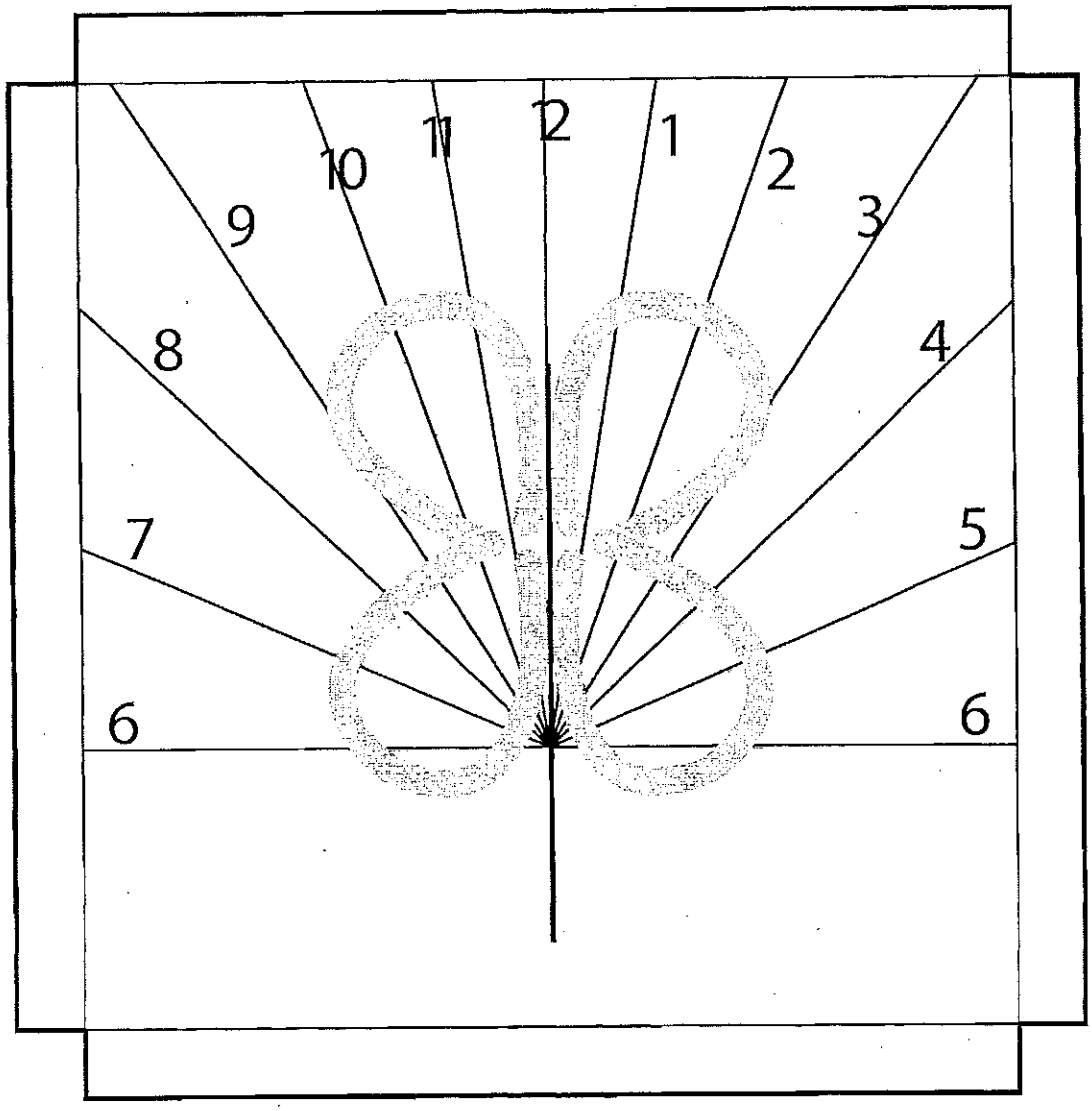
Corona Borealis



Ursa Minor

Worksheet 8.1

Sundial Base

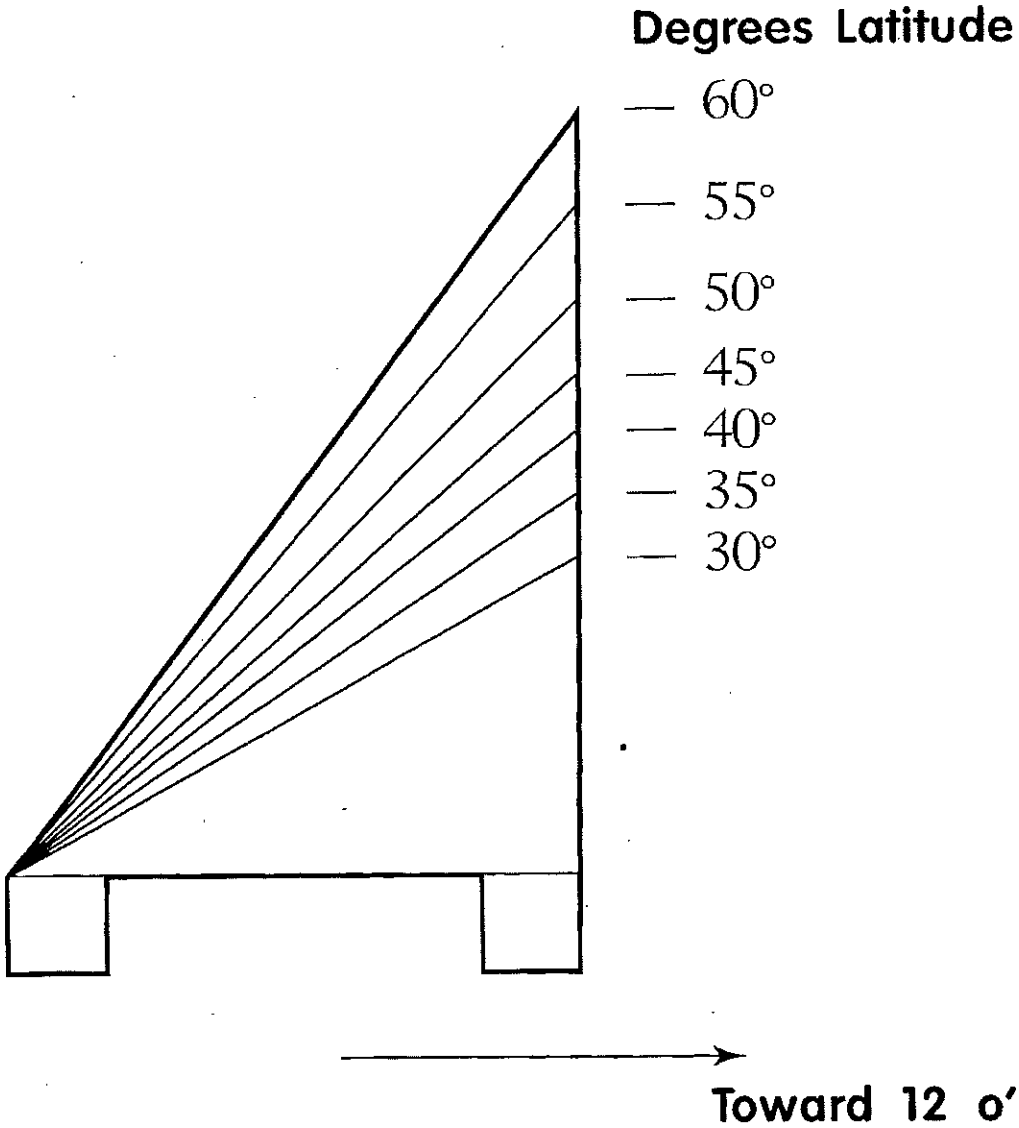


Instructions

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.

Introduction

This project is designed to provide young people with the opportunity to explore and learn about the basics of astronomy. It is written at an introductory level for students 8 to 12 years of age. The leader need not be an expert in the field of astronomy, and by participating together both leaders and members can learn about astronomy.

Nine areas of interest are presented here. Most have accompanying activities, and some have more than one. Each unit stands alone and may be done separately if necessary. Better results will be achieved if all the lessons are done in order, however. Astronomy books and supplemental guides may be helpful when viewing the night sky, and they will add to the learning experience.

Where to Begin

To start this project, the group gathers outside on a clear night just to look. This will start their thinking about and interest in astronomy. The lessons are progressive; we can use what we have learned previously. Several lessons are indoor exercises, but keep in mind that the only way to see the stars and learn them is to work with the real thing. Being outside on a clear night with a star chart and a telescope beats anything that can be done in a classroom.

Don't be discouraged if you cannot see patterns in the constellations or cannot find a constellation each time out. Like other skills, this takes practice. Let the students find the constellations—they often have vivid imaginations and will readily pick them out. We can't control cloudy nights, so keep trying—eventually the sky will clear!

Tips and Techniques for Night Viewing

- ★ Do the lessons related to what you want to see before viewing the stars at night.
- ★ The best places to view the stars are far from city lights. Because this is not always practical, try to be as far from them as possible.
- ★ Once we are outside in the darkness, using flashlights will spoil our night vision. Keep flashlights off.
- ★ If you need a light to read charts or books in the dark, cover a regular flashlight with red cellophane. Red light will not damage your night vision.
- ★ To point out stars, a large flashlight works very well as a pointer. (It is difficult to follow a pointed finger for this purpose.)
- ★ Telescopes are delicate instruments and can be easily knocked out of alignment. If your group is using telescopes, be careful around them.

1. The Stars

★ **Objective**

For each student to have a star chart of his or her own for viewing the night sky

★ **Materials**

- Scissors
- Transparent tape
- Star chart cutout kit (See Page 22, Learning Tech.)

Activity: Making a Star Chart

Reference: Worksheets 1.1 and 1.2 Star Chart Cutout

Procedures

1. Cut out the star constellation disk and holder for the star chart.
2. Insert the star constellation disk into the holder and tape down the tabs. The disk should turn freely.

★ **Objective**

To learn how to use a star chart and find your favorite constellations at any time of the year

★ **Materials**

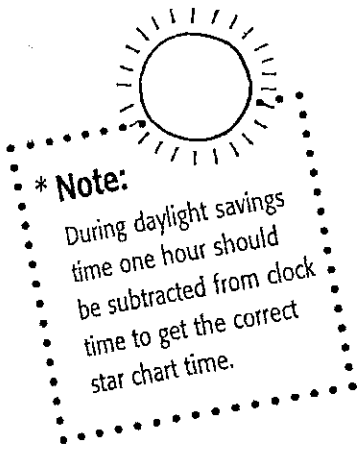
- Star chart (constructed from Worksheets 1.1 and 1.2)

Activity: How to Use a Star Chart

Procedures

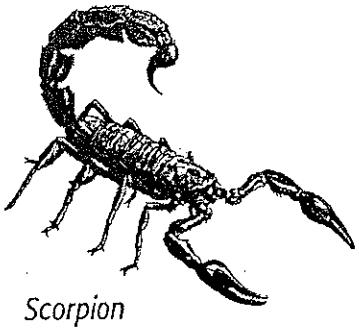
1. Holding your star chart, look around the outside edge. Note that the months are listed in a circle and the days of each month are labeled.
2. Now find the time of day that you will be observing the sky.*
3. Line up that time with the day of the month. What is showing in the oval window is the portion of the sky that can be observed at that date and time.
4. With the chart set to the correct time and date, hold the chart over your head with the "North" marking pointing north.
5. Don't worry about seeing Canis Minor as a dog or Andromeda as a beautiful girl—the ancient people had vivid imaginations! Just give it your best shot and eventually the constellations will assume their shape.
6. Find these constellations on the chart: Orion, Ursa Major (Big Dipper), Pegasus, Leo, Hercules.
7. Determine where to find certain constellations on a certain day in a specific place. For example: When will Orion be on the western horizon at 12:00 midnight? Answer: Around March 5.

Each student can pick a constellation and call it his or her own. Find what time it rises and sets and what time of the year it can be seen. Remember this constellation and look for it in the sky during a night activity.



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 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

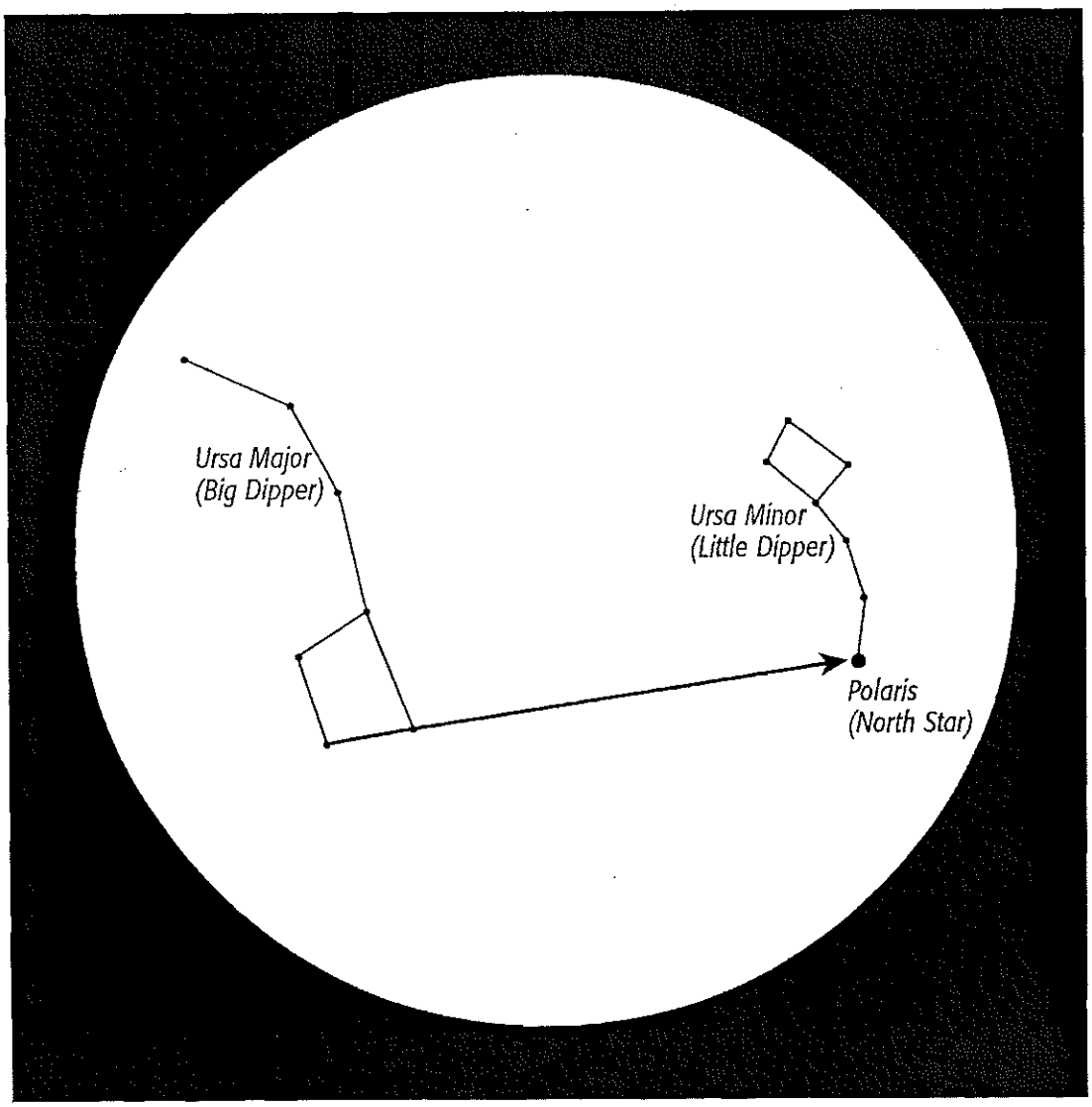
★ **Objective**

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.



Activity: Arcing Along

Reference: Worksheet 1.6 Arcing Along

★ **Objective**

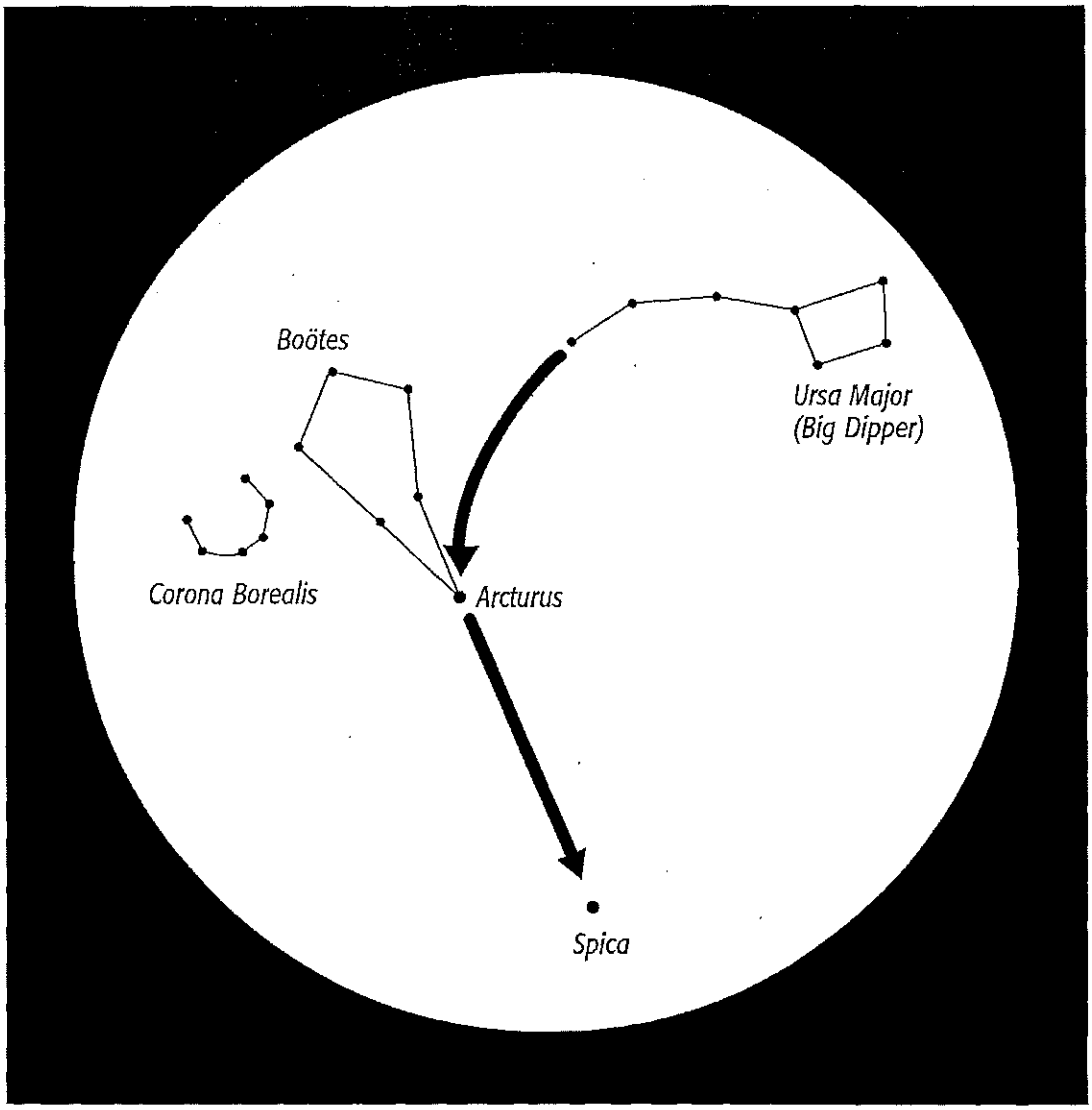
To locate other constellations using the Big Dipper

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.



Activity: Summer Triangle

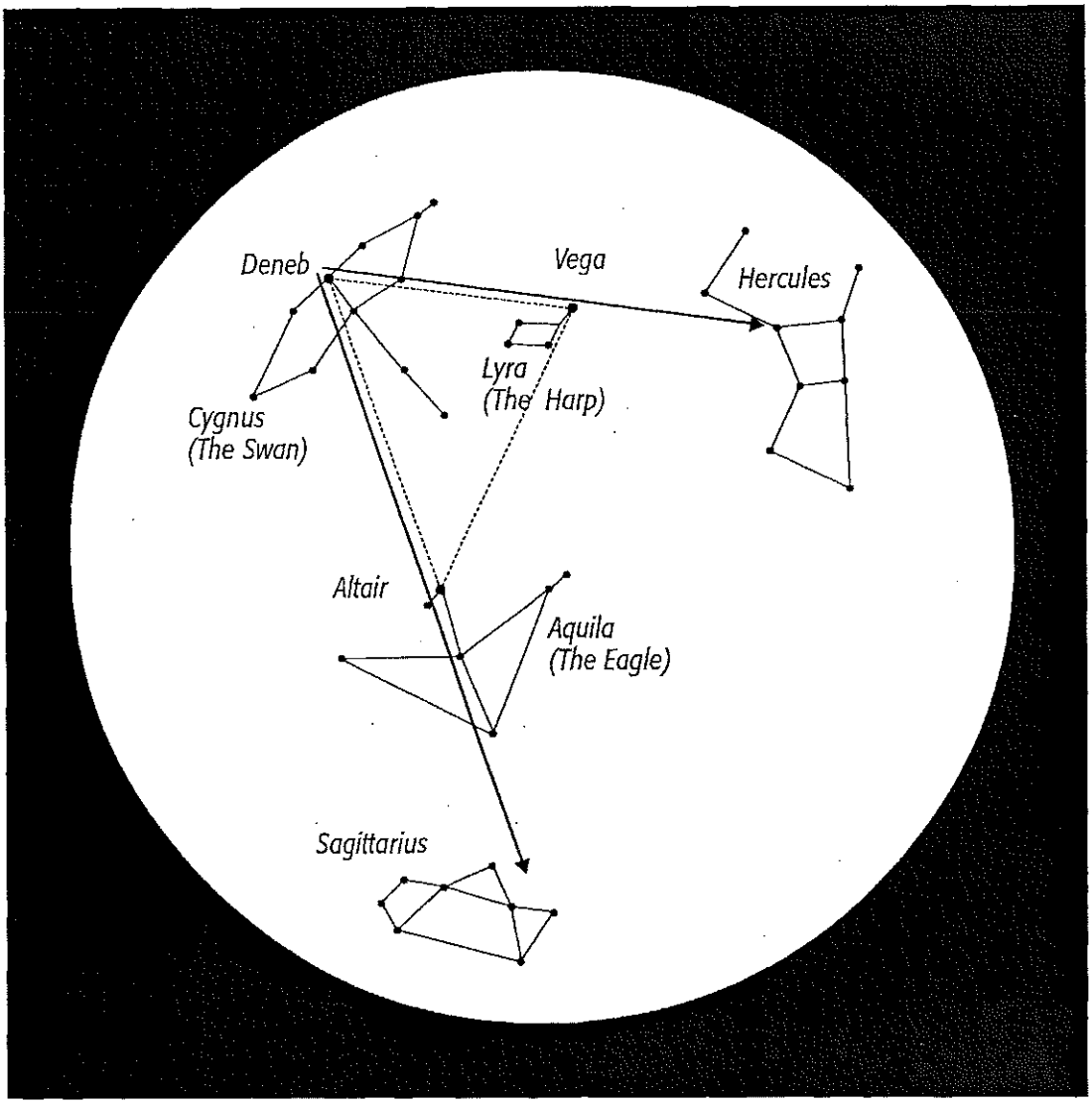
Reference: Worksheet 1.7 Summer Triangle

★ **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.



2. Night Vision

Night vision gives one the ability to see in the dark. If you have ever stepped outside at night directly from a brightly lighted room, you noticed that you cannot see well. The reason for this is that the eyes take time to adjust to the darkness. Your eyes may take up to 45 minutes to adjust completely to the darkness. When viewing the stars, you want the best night vision possible. To get this, open flashlights should never be used. If you need light, use a flashlight that has its lens covered with red cellophane or a red gel.

Activity: Night Vision

★ **Objective**

To practice seeing in the dark

★ **Materials**

- Darkened room
- Bright flashlight or camera flash

Procedures

1. Darken the room to get everyone's eyes adjusted to the darkness.
2. Once eyes are well adjusted have students cover one eye with their hand and keep that eye shut.
3. Flash the open eye with a flashlight or other bright light source for several seconds.
4. Turn lights off again, and have students open both eyes.

Questions

1. Can you see equally well with either eye?
2. What does it feel like?
3. How long does it take for both eyes to see normally again?

Answers

1. No, the eye that was flashed with the flashlight should not be able to see in the darkness.
2. Eye feels strange, hard to see out of it.
3. About 5 to 10 minutes.

3. Night Activities

Activity: Viewing

★ **Objective**
To learn about stars and constellations

Once some of the astronomy lessons have been taught, or even before, try some night viewing. This is the best way to learn about the stars and constellations; viewing the real thing is most rewarding. Remember to keep your night vision intact (see section 2, Night Vision) by using a red flashlight to read any material.

★ Stars

To view the stars, nothing is needed except your own eyes. Stars are the easiest night sky objects to see. If previous activities have been completed, then use your star chart made in section 1, Stars. This will allow you to identify the stars and learn their names. Constellations can also be picked out easily using your star chart. The worksheets from section 1, Stars, will help you navigate through a basic night sky.

★ The Moon

Note:
A full moon will be very bright in the telescope. A colored gel or moon filter can be used to block some of the light.

When the moon is up, concentrate on it because its brightness tends to block out many of the stars. During a full moon, very few stars will be visible.

The best time to observe the moon is around the first quarter and the last phases, if you get up early in the morning. This is because when the light is passing over the moon from the side, shadows in the craters are more distinct and much more surface detail can be seen. During a full moon, the sun is directly in front and the shadows are less pronounced, revealing less detail.

When using a telescope to view the moon, a higher power is often better and will give more detail of the surface.

★ Planets

Because they are not always visible, planets are a treat to view in the night sky. To find a planet use your star chart from section 1, Stars, to look for bright stars that seem to be out of place. Planets are often the brightest stars in the sky. Once a planet is found, use a telescope to view it.

★ Deep-Sky Objects

Deep-sky objects are things such as galaxies, nebulas, and clusters. They are not discussed here, but there are many books and guides that will help you find these objects with a telescope.

4. The Moon

Activity: Formation of Craters

Reference: Worksheet 4.1 Cratering Table

★ **Objective**

To model impact craters for investigating what conditions control the size and appearance of craters

★ **Materials**

- Shallow tray
- Beach sand (baking flour or loose soil will also work)
- Miscellaneous objects:

  Ball bearings
  Marbles
  Cubes
  Nuts and bolts
  Any small, hard objects
- Ruler

Impact craters are craters that form when a meteorite strikes the surface of a planet. Such craters are found on all solar system objects that have surfaces: the terrestrial planets, our moon, and many satellites of the outer planets. The occurrence and appearance of impact craters tell us about the history of cratering events. On Earth, impact craters are not easily recognized because intense weathering and erosion processes have worn away its surface. On the moon, over 80 percent of the surface looks much the same as it did $3\,^1/_2$ billion years ago. Hence the rugged, heavily cratered terrain tells us about bombardment events before that time.

Procedures

1. Fill tray with about 3 inches of leveled sand.
2. Drop objects one at a time into sand and measure size of the impact crater relative to the size of the object and from what height(s) it was dropped.
3. Use Worksheet 4.1, Cratering Table, to record your observations.

Questions

1. How does the size of the object affect the size of the crater?
2. By dropping the same object from twice the height is the crater twice as large?
3. What shape of objects made the best craters?

Answers

1. The larger the object, the larger the crater.
2. No, by measuring crater sizes you can determine that it is only about one and one half times larger.
3. Round and heavy objects.

Additional activity

Use a camcorder to tape the craters being formed. Play back the tape in slow motion or frame by frame to watch the crater being formed.

Activity: Forming Eclipses

Reference: Worksheet 4.2 Moon Phases

★ **Objective**

To understand how eclipses occur

★ **Materials**

- Darkened room
- Flashlight
- Softball
- Ping-Pong ball (taping a piece of string to it will make this easier)

Eclipses are one of the most watched and most feared events in our sky. Eclipses are nothing more than shadows. A *solar eclipse* occurs when the moon passes between Earth and the sun. As the shadow of the moon passes over Earth, it gets dark. A *lunar eclipse* occurs when the shadow of Earth passes across the moon.

Procedure for *lunar eclipses*

With the flashlight as the sun, the softball as Earth, and the Ping-Pong ball as the moon, line up the flashlight and softball. Rotate the Ping-Pong ball (moon) around the softball (Earth) and watch as it passes into the softball's (Earth's) shadow.

Procedure for *solar eclipses*

Rotate the moon around Earth, observing the moon's shadow passing across Earth.

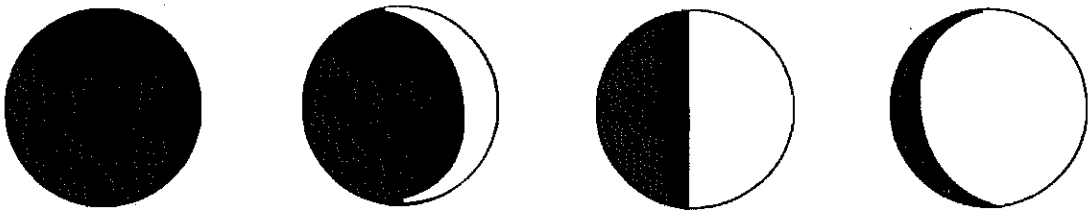
Questions

1. Can everyone on Earth see the same lunar eclipses and solar eclipses?
2. When does a lunar eclipse occur?
3. When does a solar eclipse occur?

Answers

1. Lunar eclipses can be seen anywhere on the night side of Earth.

   Solar eclipses can be seen only in the shadow that is created when the moon moves between the sun and Earth.
2. When Earth moves between the sun and the moon.
3. When the moon moves between Earth and the sun.



Activity: Demonstrating Phases of the Moon

Reference: Worksheet 4.2 Moon Phases

★ **Objective**

To demonstrate how phases of the moon occur

The moon is the easiest object to see in the night sky, and everyone has watched it go through its phases, but most people do not know what causes these phases. The new moon, waxing crescent, first quarter, waxing gibbous, full moon, waning gibbous, third quarter, and waning crescent are the names given the phases.

★ **Materials**

- Darkened room
- Softball
- Flashlight
- Three students

Procedures

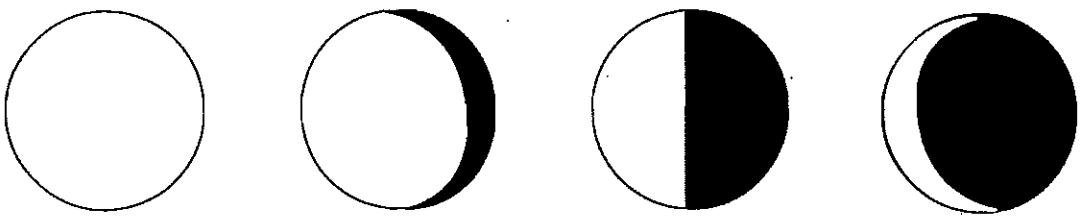
1. In a darkened room, have one person sit on a chair in the middle of the room.
2. Another person with a flashlight stands behind the first person so that the beam of light will pass directly over the seated person's head.
3. The third person needs a softball to represent the moon.
4. Have the person with the softball start from the right side of the seated person in the middle and walk slowly in a circle around the center.
5. Shine the flashlight directly over the head of the seated person in the middle so that the light beam strikes the softball.
6. Watching the softball, try to see the phases of the moon on the ball as it circles around the seated person.
7. Using Worksheet 4.2, have the students label the phases of moon in the order that they would appear in the night sky.

Questions

1. Did the shadows on the softball resemble the way the moon looks during its phases?
2. Is this an accurate representation of how the phases of the moon look from Earth?
3. Where is the moon as it is becoming full?
4. Which way does the moon revolve around Earth?

Answers

1. Yes, the shadows should look like the phases of the moon.
2. Yes.
3. Behind Earth.
4. Counter Clockwise.



5. The Solar System

The solar system is our "neighborhood." It contains the nine planets that we consider to be our "local" group. Each planet is unique and different in its own way. The planet that we all know the best is Earth, but there are eight others out there that are foreign to us. The first four—Mercury, Venus, Earth, and Mars—are called the rocky planets. They all have a hardened or rocky surface. Of these, our moon is the only member of the solar system humans have visited.

After Mars, the last rocky planet, are the gaseous planets Jupiter, Saturn, Uranus and Neptune, so called because there is no solid surface on these planets. They all are made up of different gases such as hydrogen, methane, and nitrogen. They are also very large. Jupiter, the largest, is 11 times the diameter of Earth. Saturn, with its majestic rings, is a spectacular sight by telescope. If Saturn were put in a body of water (if one could be found large enough), its low density would cause it to float. Pluto is a surface of frozen ice & rock.

★ **Objectives**

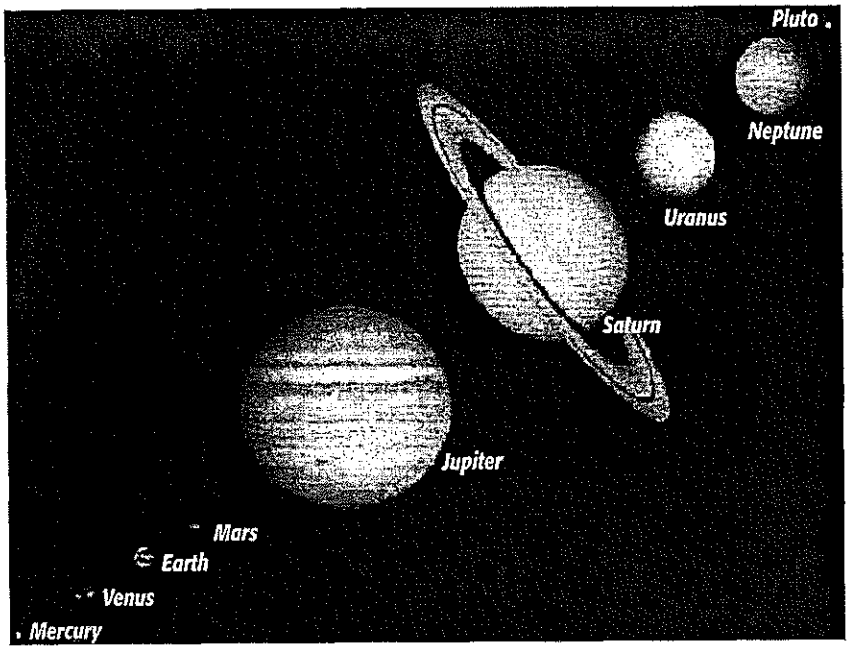
1. To comprehend the relative size and scale of the solar system
2. To learn about the planets
3. To learn about NASA programs and flybys of space probes

★ **Materials:**

- 15 feet, 100 yards, or a large field, depending on the solar system model you choose (see Table 1, p. 15)
- Materials to represent the planets (see Table 2, p. 15)

Daytime Activity: A Model of the Solar System

This activity will show the relative placement of the planets in the solar system. The larger the model, the better the representation will be. This model of the solar system will be spread out over a large field. In the large field model, the actual sizes of the



★ planets are given in relation to the sun. Give a couple of these models a try and see how big our solar system really is! All models here are an approximation of actual size.

The leader may wish to pace off the model before doing it with the student group so he or she has an idea of where the elements are placed.

Table 1. Solar System Models

Three different-sized solar system models are presented below. Note that one pace equals approximately 3 feet or one large step for an adult.

	Model Size		
Planet	15 ft.	Football field (100 yards)	Large field (approx. 6/10 mile)
Mercury	1.8 inches from sun	1 yard from sun	10 paces from sun
Venus	3.1 inches from sun	2 yards from sun	8 paces from Mercury
Earth	4.5 inches from sun	3 yards from sun	8 paces from Venus
Mars	6.8 inches from sun	4.5 yards from sun	18 paces from Earth
Jupiter	2.0 feet from sun	15 yards from sun	106 paces from Mars
★ **Saturn**	3.6 feet from sun	26 yards from sun	138 paces from Jupiter
Uranus	7.5 feet from sun	51 yards from sun	279 paces from Saturn
Neptune	11.3 feet from sun	79 yards from sun	315 paces from Uranus
Pluto	15.0 feet from sun	100 yards from sun	271 paces from Neptune

*** Note:**
Planet sizes are scaled approximately for the large field model but can also be used for the other models.

Table 2. Materials to Be Used to Represent the Planets*

Sun	Basketball
Mercury	Grain of sand
Venus	Small pea
Earth	Larger pea
Mars	BB
Jupiter	Golf ball
Saturn	Ping-Pong ball
Uranus	Gum ball
Neptune	Gum ball
Pluto	Invisible; no material to be used

Procedures

1. Assign one student to represent the sun and each planet. Have him or her line up as directed below.
2. The basketball represents our sun; it is just an average-sized star.
3. The first planet is Mercury. Take 10 paces from the basketball to place Mercury in relation to the sun. Mercury is the size of a grain of sand. It is the hottest planet, reaching temperatures of 400° Celsius (more than 800°F).
4. The next planet is Venus, located 8 paces from Mercury. This is Venus' relative distance from the sun. Venus is the size of a small pea. It is considered our twin planet because of its nearly identical size. Venus is covered with clouds of sulfuric acid and has an atmosphere of carbon dioxide. Venus is also very hot (900°) Fand would obviously not be a nice place to live.
5. The next planet is our home, Earth. Earth is 8 paces from Venus. To demonstrate that the basketball is an accurate representation of the sun, hold up your index finger up so that it covers the basketball. Doing the same with the sun will cover it, too.
6. After Earth comes the red planet, Mars. Mars is 18 paces from Earth and is the size of a small BB. Mars is the most like Earth in that its temperature on the equator is around 70°F and it has polar ice caps. Mars is red because it has a lot of rusted iron in its surface.
7. Next outward from Mars is Jupiter, the "king of the planets." Jupiter is 106 paces from Mars and is about the size of a large walnut or Ping-Pong ball. Looking back at the sun, it appears to be very small. Jupiter is the largest planet, but it has no hard surface—it is all gases. One interesting feature of Jupiter is the Great Red Spot, which is believed to be a huge storm that has been raging for years in the atmosphere. Jupiter has four moons, all of which can be seen through a telescope. They are Io, Europa, Ganymede, and Callisto.
8. From Jupiter we go on to Saturn, the ringed planet. For Saturn, place the smaller walnut 138 paces out from Jupiter. Like Jupiter, Saturn is made up of gases. Saturn has such a low density that it would float if you could find a body of water large enough to hold it!

At this point in the tour you are only one-fourth of the way through the solar system. Uranus, Neptune, and Pluto would be three times as far as you have already walked, so Saturn will be the last planet we will visit.

On the way back to the sun you can talk about the size of stars. The largest of the stars, a super red giant, would have a center at the sun and extend out to Jupiter. The smallest of the stars, a white dwarf, is approximately the same size as Earth. From upstate New York the nearest star to the basketball would be another basketball in Moscow, Russia.

Additional activity

Observe: While walking through the model, guess how far away the next planet will be.

Observe: Show pictures of the real planets for an idea of what they look like.

Compare: Explain the size relationship between the scale model and the solar system itself.

Additional projects

Do research on the planets. Students can do this as groups or individually. They can make models and give a short presentation on their planet.

★ **Objective**

To find the planets in the sky

★ **Materials**

- Telescope or binoculars
- Star chart
- Clear night

Nighttime Activity: Observing the Planets

Procedures

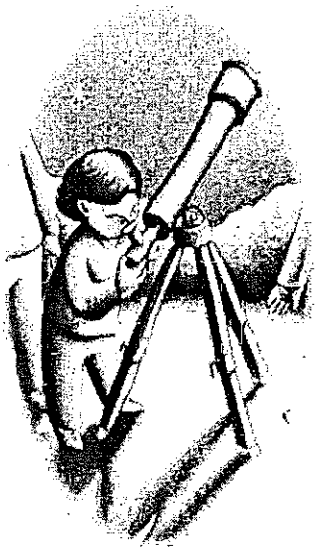
1. Find a planet in the sky. This can be done by using the star chart and looking for stars that are not supposed to be there. Or look for the brightest object in the sky, which is usually a planet.
2. Things to look for on each planet:

   Jupiter—four Galilean moons and the Great Red Spot

   Saturn—rings

   Venus—crescent moon shape

   Mars—reddish color



Advance preparation for leaders: You may wish to determine if any planets are visible in the night sky in your area and locate the planet before the groups meets so that you can quickly identify the planet with the students.

6. Telescopes

★ **Objective**

To demonstrate how a pinhole viewer inverts light passing through it, as does a telescope lens

★ **Materials**

- Cylindrical oatmeal container or similar cardboard canister†
- Tracing paper
- Rubber band
- 2 candles
- Sharp knife
- Pin
- Aluminum foil
- Transparent tape
- Darkened room

Telescopes are made from either lenses or mirrors. The first telescopes were made from two lenses in a tube. As technology improved, lenses became better and eventually mirrors were used to collect the light. These experiments show image reversal and how to make a very primitive telescope from two magnifying glasses.

Activity: A Pinhole Viewer*

Procedures

1. Using the knife, cut a ½-inch hole in the bottom of the oatmeal container.
2. Cover the hole with aluminum foil and, with the pin, poke a hole in the center of the foil.
3. Cover the open end of the container with the tracing paper and secure it with a rubber band.
4. Darken the room and light candles.
5. Point the pinhole viewer so that the pinhole faces the candles. Observe the image on the tracing paper.

Question

How does the image compare to what you see with your eye: that is, upside down, upright, backwards?

Answer

The image should be upside down and reversed.

Note:

* This activity was adapted from the *Space Based Astronomy Teachers Guide* from NASA.

† If you have completed section 7, A Constellation Viewer, the can from your constellation telescope may be used.

Activity: A Simple Telescope

★ **Objective**

To show that a telescope can be nothing more than two simple lenses

★ **Materials**

- 2 magnifying glasses, any quality

Procedures

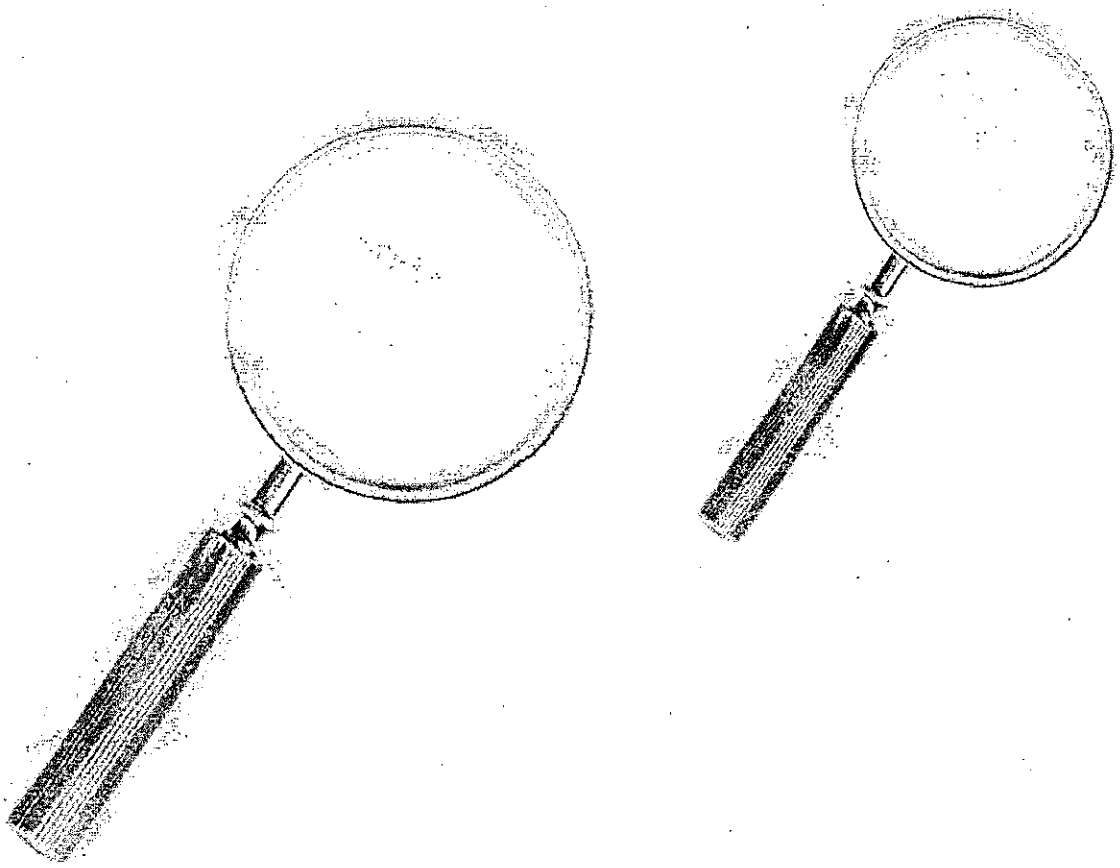
1. Take one magnifying glass in each hand.
2. Hold one glass close to your eye (approximately 3 inches).
3. Hold the other lens approximately 1 foot away.
4. Move the second (farther) glass until the objects seen through the lens come into focus.

Questions

1. Are the objects larger or smaller than before?
2. Is what you see through lens upside down or right side up?
3. How clear are the images?

Answers

1. Larger.
2. Upside down.
3. Depending on the quality of the magnifying glasses, they should be good.



7. A Constellation Viewer

Activity: Building a Constellation Viewer (or, the "Pringles Planetarium")

References: Worksheet 7.1 Constellation Patterns
Worksheet 7.2 More Constellation Patterns

★ **Objective**

To create a way to view the constellations indoors, at any time of day

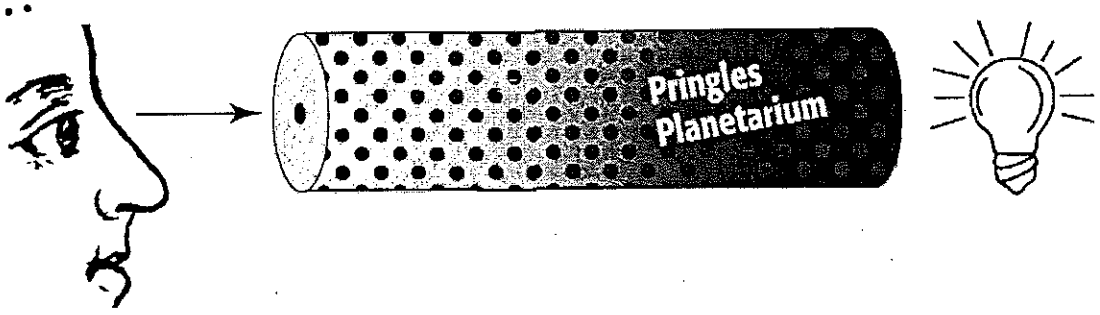
★ **Materials**

- Pringles potato chip can with cap (or similar container)
- Construction paper
- Hammer
- Large and small nails

Procedures

1. Place the can on top of black or dark-colored construction paper and trace around it.
2. Cut out the circle.
3. Place the circle under constellation patterns on Worksheets 7.1 and 7.2, and prick holes through into the construction paper where each star would be. More than one constellation can be punched out for exchange within the group to collect an assortment of constellations.
4. Use hammer and large nail to punch one large hole in the metal end of the can.
5. Place the constellation disk in the cap and snap it onto the end of the container.
6. Decorate the can in any fashion you like; use markers, construction paper, or other materials.
7. To use, point the capped end of the container toward a light source. Look through the hole in the bottom of the container. The constellation will appear in the cap.

Note:
The leader or older students may want to help the younger students in making the holes in the cans.



8. Sundials

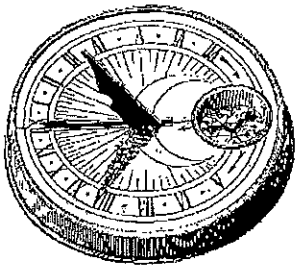
Sundials are the oldest time-measuring devices. They work on the simple principle that as the sun moves through the sky, the gnomon, or centerpiece pointer, casts a moving shadow on the dial to indicate the passage of time. The basic sundial has the gnomon pointing toward the North Star and 12 o'clock facing north. To find the North Star, see section 1, Stars.

Activity: Building a Sundial

References: Worksheet 8.1 Sundial Base (hour scale)
Worksheet 8.2 Sundial Gnomon (pointer)

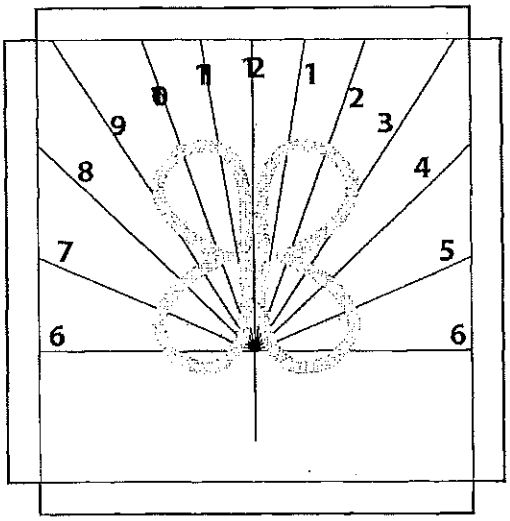
★ **Materials**

- Scissors
- Transparent tape
- Markers and crayons
- Block of wood or small stones



Procedures

1. Cut out the dial face and gnomon from worksheets. The angle of the gnomon must be cut to your latitude, which can be determined by looking at a globe or atlas. (For example, Philadelphia is at approximately 40° latitude, Binghamton at 42°, Syracuse and Buffalo at 43°, and Watertown and Burlington at 44°.) The latitude lines on the gnomon are marked in 5-degree intervals.



2. Tape or glue the gnomon onto the face of the dial so that it points toward 12 o'clock.
3. Color to suit using markers or crayons.
4. Take your sundial outside on a sunny day. If wind causes a problem, gluing the face to a block of wood is one way to give your sundial weight so that it will not blow away. Or stones may be used to weight the paper.
5. Point 12 toward north, and read the time on the dial.

Note:
During daylight savings time one hour must be added to the time on the dial to equal real time.

9. Resources and Information

Astronomy Periodicals

★ **Learning Technologies**
You can purchase star chart from: Learning Technologies
40 Cameron Ave. Sommerville, MA 02144.
Phone: 800-537-8704

★ *Sky & Telescope*
49 Bay State Rd., Cambridge, MA 02238 800-253-0245
Monthly sky maps, news for amateur astronomers, major articles by professional astronomers describing recent discoveries, book reviews, advertising for books, telescopes, and observing aids.
Web Site: www.skyandtelescope.com

★ *Astronomy*
21027 Crossroads Circle, Waukesha, WI 53187-9950
A well-illustrated, popular magazine. Monthly features include astronomy and space news, informational articles, planet and star charts, book reviews, advertising by vendors of telescopes and accessories. Web Site: www.astonomy.com

★ *Mercury*
Astronomical Society of the Pacific
390 Ashton Ave., San Francisco, CA 94112
Nontechnical magazine about astronomy for general readers, amateur astronomers and teachers

The Astrograph
★ Box 369, Dumfries, VA 22026
A bimonthly magazine devoted to astrophotography, from basic principles to the techniques used by advanced amateur astronmers. Informative articles on the latest equipment, films, and techniques.

Equipment Vendors

Telescopes, binoculars, spotting scopes, and accessories. Call for catalogs. Advertising for these vendors and others appears regularly in the periodicals listed above.

★ *Astroptx*
57 North Street, Suite 40.
danbury, CT 06810
Web Site: www.astroptx.com

★ *Celestron*
310-328-9560
Web Site: www.celastron.com

★ *Edmund Scientific Co.*
C915 Edscorp Building
Barrington, NJ 08007
800-728-6999 Web Site: www.scientificsonline.com

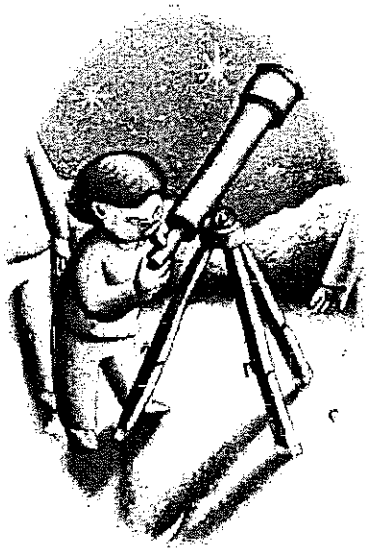
★ *Orion Telescope Center*
800-447-1001 Web Site: www.telescope.com

Meade Instruments Corporation (California)
★ 800-62-meade Web Site: www.meade.com

Favorite Links

http://edspace.nasa.go/index.html
http://www.nasa.gov/audience/forkips/home.html
http://astronomylinks.com (Over 1000 links)
http://dmoz.org/science/astronomy (Over 3,500 links)
http://hubblesite.org (Great Pictures)
http://www.kidskonnect.com (All kinds of space information)
http://astonomy.com (Current news & topics)
http://www.aces.edu/dept/4haero/
http://imagine.gsfc.nasa.gov/docs/homepage.html
http://amazing-space.stsci.edu/
http://starchild.gsfc.nasa.gov/docs/starchild/starchild.html
http://www.jpl.nasa.gov/kids/index.html
http://spaceplace.jpl.nasa.gov/index.shtml
http://astronomy.net
http://astonomyclubs.com

Notes



Astronomy: It's Out of This World is designed to provide young people with hands-on opportunities to explore the basics of astronomy. It is written for students 8 to 12 years of age. The leader need not be an expert in the field of astronomy, and by participating together, both adults and children can enjoy learning about astronomy.

Nine areas of interest are presented; most have accompanying activities, and some have more than one. They include constellation matching, mythology, connecting the dippers, finding certain constellations, exploring the Summer Triangle, moon phases, understanding and making a sundial, and more.

The author walks you through the solar system and using telescopes. He makes searching the night sky fun while you learn. His tips on how to make the most of night viewing will be useful to anyone. By using these easy, but very informative, hands-on ideas students and adults will retain what they learn and have a better appreciation for astronomy.