

# ***A Collection of Curricula for the STARLAB® Celestial Coordinates Cylinder***

*Including:*

*A Look at the Celestial Coordinates Cylinder by Joyce Kloncz*

*Comparing Star Locations from Points on the Earth by Joyce Kloncz*

*Name That Star!! by Gerald L. Mallon, Ed.D.*





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# A Look at the Celestial Coordinates Cylinder

by Joyce Klonc

## Introduction

This cylinder is an excellent tool to begin to teach the study of astronomy coordinates to young children. The following are some ideas you can use to introduce this cylinder.

## Note

*In this planetarium activity, text that is in italics is suggested script for the teacher to use, but not necessarily intended to be read word for word.*

## Objectives

To introduce the terms right ascension and declination to students, and to use that information to find specific star locations.

## Process Skills

Describing • observing • interpreting • communicating • inferring • working cooperatively

## Procedure

These activities for the Celestial Coordinates Cylinder work especially well after children have used the Earth Cylinder and have some background on how lines of latitude and longitude are used to determine locations on our Earth. Before showing the cylinder, have the house lights dimming and the projection lights slowly brightening. Ask the children to imagine that astronomers now have extended those lines of latitude and longitude out into space.

*Our equator is called the celestial equator by astronomers. Our latitude is called declination by astronomers. Our longitude is called right ascension by astronomers. Astronomers simply set these coordinates for their telescopes and can easily find the star for which they are looking.*

Point out the precession circle and discuss how the star Polaris hasn't always been our North Star and will not always be our North Star, because of the way our Earth wobbles through space. Show where Vega is and talk about why this will be our North Star in another 10,000 years because of this precession. Point out the celestial equator line, Milky Way line, the ecliptic line, right ascension lines, and declination lines. Discuss why these lines are important on the Celestial Coordinates Cylinder. Find some important constellations with which the children are familiar, such as the Big and Little Dipper, Orion, Gemini Twins, Canis Major and Minor, Leo the Lion, Taurus the Bull, Auriga the Charioteer.

*Every star you see in STARLAB has an "address in space."*

- Find Betelgeuse in the constellation Orion. See if the students can figure out its right ascension and declination address. (RA 05 54.9, DEC +7 24. Round these numbers off for young children, i.e. 5 hours, 54 minutes, 7° north latitude.) Find some important stars that students have already worked with on the Starfield Cylinder, such as Sirius, Rigel, Bellatrix, Saiph, Castor, Pollux, Regulus, Aldebaran, Procyon, Capella, Polaris, and Spica.
- Have students work with teams of two or three partners. Hand out small slips of

## MATERIALS

- STARLAB Portable Planetarium
- Celestial Coordinates Cylinder
- star name slips
- pencils
- clipboards (optional)
- arrow pointers

paper (see next page) to each group giving them one of the different star names. Have them work together and write its right ascension and declination coordinate next to its name. Share information by having students again find their star on the cylinder and telling its right ascension and declination location. Hand out answer slips.

### Directions

Cut up the following star names and distribute one to each pair or groups of three students.

Sirius: RA\_\_\_\_\_ DEC\_\_\_\_\_

Rigel: RA\_\_\_\_\_ DEC\_\_\_\_\_

Bellatrix: RA\_\_\_\_\_ DEC\_\_\_\_\_

Saiph: RA\_\_\_\_\_ DEC\_\_\_\_\_

Castor: RA\_\_\_\_\_ DEC\_\_\_\_\_

Pollux: RA\_\_\_\_\_ DEC\_\_\_\_\_

Regulus: RA\_\_\_\_\_ DEC\_\_\_\_\_

Aldebaran: RA\_\_\_\_\_ DEC\_\_\_\_\_

Procyon: RA\_\_\_\_\_ DEC\_\_\_\_\_

Capella: RA\_\_\_\_\_ DEC\_\_\_\_\_

Polaris: RA\_\_\_\_\_ DEC\_\_\_\_\_

Spica: RA\_\_\_\_\_ DEC\_\_\_\_\_

#### Answer Key to Celestial Coordinates of Familiar Stars

(If necessary, round off these numbers to make it easier for students to understand.)

*Sirius: RA 06 44.9, DEC -16 42*

*Rigel: RA 05 14.2, DEC -8 13*

*Bellatrix: RA 04 24.9, DEC +6 20*

*Saiph: RA 04 24.9, DEC +6 20*

*Castor: RA 07 34.2, DEC +31 55*

*Pollux: RA 07 45.0, DEC +28 03*

*Regulus: RA 10 08.1, DEC +12 01*

*Aldebaran: RA 04 35.6, DEC +16 29*

*Procyon: RA 07 39.1, DEC +5 15*

*Capella: RA 05 16.2, DEC +45 59*

*Polaris: RA 02 24.7, DEC +89 14*

*Spica: RA 13 24.9, DEC -11 07*

# Comparing Star Locations from Points on the Earth

by Joyce Kloncz

## Note

*In this planetarium activity, text that is in italics is suggested script for the teacher to use, but not necessarily intended to be read word for word.*

## Objectives

Students will find that stars appear in different locations if they live at the North Pole, at the mid-latitudes, or at the equator.

## Process Skills

Describing • observing • interpreting • communicating • inferring

## Procedure

After students have successfully found the celestial coordinates of specific stars, ask them to think how stars appear at various locations on our Earth. Set the latitude for 45° north latitude. Find Orion, the Big Dipper and Polaris at this latitude using the arrow pointers. Have children take turns locating these constellations.

*Imagine that you are living at the North Pole or at the equator. Will the stars look different to you at those places?*

(To make it easier for students to visualize, use Orion, the Big Dipper, and Polaris, easily found constellations for students.)

Ask: “Where will Orion, the Big Dipper and Polaris appear to people living at the North Pole?” (Entertain guesses from students on how the sky will look different to those of us living at mid-latitudes.)

Now set the latitude on the projector to 90° north latitude by tilting the Celestial Coordinates Cylinder straight up so that it appears that we are at the North Pole.

Ask: “What star is directly overhead?” (Polaris or the North Star.) “Where is the Big Dipper?” (Overhead.) “Where is Orion now?” (At the horizon.) “What will happen if we set the cylinder latitude for 0° — the equator? Where will Orion, the Big Dipper and Polaris be now?” (Have students guess on those locations. Orion will be overhead and Polaris and the Big Dipper will be down near the horizon.)

Students enjoy seeing that children at the equator see Orion overhead and the Polaris near the horizon, but children at the North Pole see Polaris overhead and Orion at the horizon. Discuss what would be children’s favorite constellation at the North Pole? At the equator? At mid-latitudes?

## Evaluation

Use student responses to determine where Orion, the Big Dipper, and Polaris are at the North Pole, the mid-latitudes, and the equator, or prepare a data sheet asking for that information.

## MATERIALS

- STARLAB Portable Planetarium
- Celestial Coordinates Cylinder
- arrow pointers

## MATERIALS

- STARLAB Portable Planetarium
- Celestial Coordinates Cylinder
- Greek Mythology Cylinder
- Star Chart worksheets
- pencils
- slides and transparencies
- overhead projector
- slide projectors
- box with slips of paper listing coordinates for given stars
- tape player
- tape of appropriate musical clues (see sample list)
- tape of “game show” introduction for the “Name that Star” game

# Name That Star!!

by **Gerald L. Mallon, Ed. D.**

### Note

*In this planetarium activity, text that is in italics is suggested script for the teacher to use, but not necessarily intended to be read word for word.*

### Purpose

To examine the celestial coordinates system and to practice its use, by locating specific stars by their coordinates, and then guessing the name or constellation of the star by means of a musical “clue.”

### Objectives

By the end of this unit, students should be able to:

1. Use a star chart to locate specific stars, if given the coordinates (right ascension and declination) of the stars.
2. Locate on the planetarium dome (with coordinates projected on the dome) a specific star or constellation, if given the coordinates.
3. Explain the similarities and differences between the Earth and the celestial coordinates system, defining the terms right ascension and declination.
4. Identify a particular star or constellation by name, if given the coordinates and a musical clue (example: “Teddy Bears on Parade” for Ursa Major or Minor).

### Preparation

The STARLAB projector should be set for approximately 40° North latitude. 0 hours of right ascension should be directly over south. Students should already have completed the worksheets on coordinate systems and on celestial coordinates before attending the planetarium program.

### Procedure

Students are welcomed to the planetarium and the purpose of the lesson is explained. Students will be able to practice using the celestial coordinates system and also learn about the constellations and stars of the night sky by participating in a special game. The class will be divided into two teams competing to see which team accumulates the most points in the “Name that Star!” game. Explain the rules and procedures for the game as follows.

*Each team will take turns working on a problem. For each problem, one team member will take the role of “Team Captain.” The person serving as “Team Captain” will change after every problem. The team members can consult with each other on possible answers but the Team Captain must give the final answers to the judge.*

*Each problem will have two parts. First, they must locate the given star on the dome of the planetarium by using the star’s coordinates of right ascension and declination. To do this, the Team Captain must instruct the planetarium director to move the stars to the east or the west, until the chosen star is directly over south (on the meridian). Second, the Team Captain must identify the star either by its individual name, or by naming the constellation of which it is part.*

*Twenty-five points will be awarded for locating the correct star on the first try. If it takes more than one try, the number of points awarded is reduced by five for each successive try, until the proper star is located. Once the star is found, twenty-five points will be awarded for naming the star or constellation by sight recognition without the use of the musical clue.*

*For each unsuccessful attempt at naming the star or constellation, the number of points to be awarded is reduced by five. After five unsuccessful tries, the other team can attempt to name the star or constellation for twenty-five points.*

- After explaining the rules of the game, demonstrate the process using a sample problem. When everyone is comfortable with the procedure, flip a coin to determine which team will go first. Either choose a "Team Captain" at random or ask the team to designate the captain. (Remind them that the captain must change with each problem.) Play the "Name that Star" theme show tape and proceed with the game. The first captain should pull a slip out of the box, listing the coordinates for a given star. The coordinates should be repeated out loud so that everyone will know the area in question. (This will also give the planetarium director the opportunity to advance the tape to the appropriate clue for the selected star.) The Team Captain should then determine if the planetarium projector should be rotated to the east or the west to bring the given star into view. According to the rules of the game, the star should be located and positioned over south, and then the star or the constellation should be named. If the star or constellation cannot be named by sight, then play a musical clue for that star. Each team should have no more than one minute to attempt to name the star before the other team is given their opportunity. When the first team has completed their round, repeat the procedure with the other team.
- The process of locating stars by coordinates and then naming them by sight or with the help of a clue should continue for the length of the class period. Preferably the classroom teacher (or if necessary, the planetarium director) can serve as the score keeper, keeping track of the points accumulated by each team. At the end of the lesson, the winning team should be announced and some small prize may be awarded. (This can vary from a "free pass" for missed homework, to ice cream snacks, to stickers, etc.)
- Conclude the lesson by reminding everyone of the importance of coordinates in many areas of life, and then thank everyone for participating.

## Musical Clues to the Stars

Below is a list of songs that could serve as possible “musical clues” to suggest the names of various constellations. You may wish to assign the task of locating such clues to students before the lesson. You could distribute a list of constellation or star names, and ask the students to list songs that might match them. Students could then bring to school the records or tapes that contain the clues, and a master set of clues could be compiled.

As an alternative, you may ask students after they’ve participated in the lesson to submit clues to use for future lessons.

<b>Constellation</b>	<b>Possible Clues</b>
Leo the Lion	<i>The Lion Sleeps Tonight; Be a Lion</i>
Virgo the Virgin	<i>Like a Virgin</i>
Auriga the Charioteer	<i>Chariots of Fire</i>
Canis Major the Big Dog	<i>How Much is that Doggie in the Window; Bark at the Moon</i>
Orion the Hunter	<i>Peter and the Wolf (the hunter)</i>
Cetus the Whale	<i>Theme from Jaws; Greenland Whale Fisheries</i>
Taurus the Bull	<i>Espana Cani (Bullfight song)</i>
Pleiades the Seven Sisters	<i>Girls Just Wanna Have Fun; Sisters</i>
Lepus the Rabbit	<i>Jump; Here Comes Peter Cottontail</i>
Draco the Dragon	<i>Puff the Magic Dragon</i>
Ursa Major the Big Bear	<i>House at Pooh Corner; Teddy Bears on Parade</i>
Cassiopeia the Queen	<i>Dancing Queen; Queen for a Day</i>
Cepheus the King	<i>King for Just One Day</i>
Hydra the Snake	<i>Union of the Snake</i>
Gemini the Twins	<i>Me and My Shadow; Hands Across America</i>
Aquila the Eagle	<i>The Eagle and the Hawk, Fly Away</i>
Cygnus the Swan	<i>Swan Lake</i>
Lyra the Harp	<i>Au Clair de la Lune</i>
Pegasus the Winged Horse	<i>William Tell Overture</i>
Pisces	<i>Three Little Fishes; Swim, Swim, Swimmy</i>



## Pre-visit Activity

### Note

*In this planetarium activity, text that is in italics is suggested script for the teacher to use, but not necessarily intended to be read word for word.*

### Purpose

To examine the use of coordinate systems as a means of locating given points or places, and in particular to study the celestial coordinates system.

### Objectives

By the end of this unit, students should be able to:

1. Explain the mechanics of using coordinate systems, giving examples such as road maps and latitude and longitude.
2. Locate a set of specific stars, if given the coordinates (right ascension and declination) of the stars and an appropriate star chart.
3. Compare the similarities and differences between the Earth and the celestial coordinate systems, defining the terms right ascension and declination.

### Note

*This exercise may be done either in class or as a homework assignment. If it is to be administered in class then the following procedure applies.*

### Procedure

Explain to the class the purpose of the activity. Use the globe and the street map to emphasize the point that systems of coordinates are used to locate positions.

*On Earth, maps may use a system of coordinates such as latitude and longitude to mark the positions of cities. On street maps, a system of coordinates using letters and numbers may be used to mark the positions of streets. In the sky, a system of celestial coordinates called right ascension and declination is used to mark the positions of objects. In all the cases listed above, the coordinate systems involve two measurements. One measurement tells you how far “up or down” to go from some beginning point, and the other measurement tells you how far “side to side” to go from some beginning point. Using both coordinates allows you to find the desired spot. Because coordinates are so important, you will have various opportunities to practice using them. For your first activity, you will receive a worksheet and a sheet of graph paper. Using the graph paper and the set of given points, complete the exercise as follows:*

1. Locate each of the points listed and label them with the corresponding number.
2. Starting with the point labeled #1, draw a line connecting the points together — in order.
3. Identify the object, and when everyone has finished, check your work with your classmates.

Ask: “Were any mistakes made? Did anyone mark a point ‘+’ when it was supposed to be ‘-’? How did this change the result?”

### Procedure

Distribute the materials to the class. Circulate among the students, offering help as needed. When the class has finished, review their work and then proceed with the

## MATERIALS

- worksheets
- Earth globe
- road map
- celestial sphere

second activity explaining the mechanics of the celestial coordinates system.

*The celestial coordinate system is based on an imaginary ball of stars around the Earth called the “celestial sphere.” This sphere has certain points from Earth superimposed upon it. For example, the celestial equator is an extension of the Earth’s equator; the north celestial pole is an extension of the Earth’s North Pole, and the south celestial pole is an extension of the Earth’s South Pole. Declination is measured north or south of the celestial equator (an up-and-down measurement) in units called degrees. Right ascension is measured around the celestial sphere (a side-to-side measurement). It is usually measured in units called hours and minutes but will sometimes appear in degrees.*

*For your second activity, you will attempt to find a series of stars using their coordinates. Using the celestial map, locate the stars and put a circle around them and the appropriate number next to them. Number 1 has already been done for you.*

#### **Procedure**

Distribute the materials to the class and offer help as needed. Conclude the lesson by reviewing how coordinate systems work.

*On Earth, maps may use a system of coordinates such as latitude and longitude to mark the positions of cities. On street maps, a system of coordinates using letters and numbers may be used to mark the position of streets. In the sky, a system of celestial coordinates called right ascension and declination is used to mark the positions of objects. Now that you have experience in these systems of celestial coordinates, you’re ready for a visit to a STARLAB Portable Planetarium where you will be able to practice your skills with the Celestial Coordinates Cylinder.*

#### **Extension Activity**

Since the STARLAB Portable Planetarium lesson will use constellation names and their translations as well as the celestial coordinate system, it is important that students have some knowledge of this topic. The worksheet Match the Constellations (page 11) can help students to learn some of the names that will be used in the lesson. The students can also be encouraged to find the names of the remaining 66 constellations. [Answer Key for the worksheet is in the lefthand column.]

#### **Answer Key for “Match the Constellations” Worksheet (page 11)**

1. F
2. O
3. P
4. V
5. N
6. C
7. R
8. U
9. A
10. D
11. J
12. S
13. T
14. E
15. Q
16. K
17. L
18. G
19. I
20. B
21. M
22. H

### Match the Constellations Worksheet

Constellation names and what they represent can be somewhat confusing. (Lepus the rabbit?) To find out more about these starry images, try matching the constellation names listed below with their English translations.

- |                      |                             |
|----------------------|-----------------------------|
| 1. _____ Andromeda   | A. Whale                    |
| 2. _____ Aries       | B. Big Bear                 |
| 3. _____ Aquila      | C. Little Dog               |
| 4. _____ Auriga      | D. Swan                     |
| 5. _____ Canis Major | E. Rabbit                   |
| 6. _____ Canis Minor | F. Princess                 |
| 7. _____ Cassiopeia  | G. Seven Sisters            |
| 8. _____ Cepheus     | H. Maiden — Virgin          |
| 9. _____ Cetus       | I. Bull                     |
| 10. _____ Cygnus     | J. Dragon                   |
| 11. _____ Draco      | K. Flying Horse             |
| 12. _____ Gemini     | L. Fish                     |
| 13. _____ Leo        | M. Little Bear              |
| 14. _____ Lepus      | N. Big Dog                  |
| 15. _____ Orion      | O. Ram                      |
| 16. _____ Pegasus    | P. Eagle                    |
| 17. _____ Pisces     | Q. Hunter                   |
| 18. _____ Pleiades   | R. Queen                    |
| 19. _____ Taurus     | S. Twins                    |
| 20. _____ Ursa Major | T. Lion                     |
| 21. _____ Ursa Minor | U. King                     |
| 22. _____ Virgo      | V. Goat Keeper (Charioteer) |

## MATERIALS

- Worksheets

## Post-visit Activity

### Note

*In this planetarium activity, text that is in italics is suggested script for the teacher to use, but not necessarily intended to be read word for word.*

### Purpose

To examine how “navigation stars” can be used to mark points in the sky, and to practice using the celestial coordinates system.

### Objectives

By the end of this unit, students should be able to:

1. Explain how navigation stars can be used to help determine one’s current position in space or chart a course to a new location.
2. Determine the predicted position of the moon using the celestial coordinate system (specifically right ascension) knowing that the moon moves approximately 54 minutes of right ascension per day.

### Note

*This exercise may either be done in class or as a homework assignment. If it is to be administered in class then the following procedure applies.*

### Procedure

Explain to the class the purpose of the activity.

*Astronauts use “nav stars” (navigation stars) for space navigation. They are trained to identify various starfield patterns and the navigation stars that are found within the patterns. The measuring of the position of the navigation stars can help to determine one’s current position in space or help to chart a course to a different location. Charting a course to a body in space is no easy matter, especially since, in space, things are always moving!*

*Take the example of the moon. If one were to leave from the Earth on a trip to the moon, and charted a course directly towards the moon on the day of departure, the ship would not reach the moon! By the time the ship reached the correct distance to the moon, the moon would have moved in its orbit around the Earth and would no longer be in the same place! In order to reach the moon, the navigator must be able to predict the future position of the moon for the time that it will take to reach the proper distance, and then chart a course to that predicted position by determining the nav stars in that area.*

*Given that the moon moves eastward through the zodiac at the approximate rate of 54 minutes of right ascension per day, determine the following information for each of the problems:*

- a) The name of the starfield (constellation) for the position of the moon for the first date given.
- b) The approximate position of the moon as measured in right ascension (using the units of hours and minutes) for the day of arrival.

- c) The appropriate nav star to use for the trip (the one closest to the predicted position of the moon for the arrival date). Note: it should be in the zodiac. List the nav star's number.

Before distributing the worksheets, offer the students a demonstration of the procedure as follows.

*Let's use an example: Your ship departs Earth's orbit on September 4. The moon is located at 2 hours 25 minutes. Your expected arrival date is September 9. First, review the star chart and determine the name of the constellation for the moon for the departure date (Sept. 4). The moon was located at 2 hours and 25 minutes, thus putting it in Aries. Next, multiply 54 minutes by 5 days and then divide by 60 minutes to determine the number of hours that the moon would have moved during the six day period.*

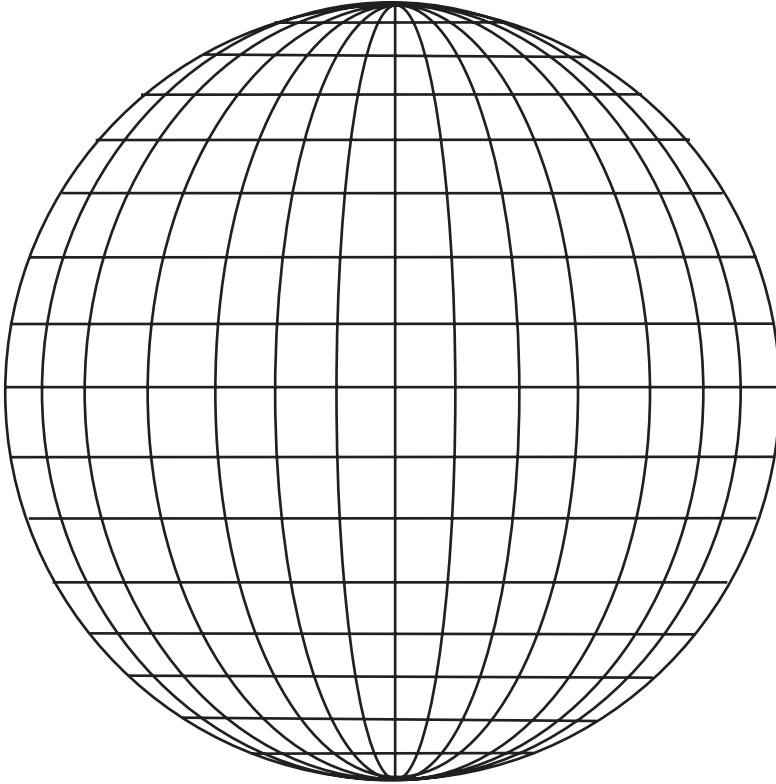
**Note**

Do not use fractions or decimals for this problem. Instead determine the whole number of minutes remaining.

*54 minutes multiplied by 5 days equals 4 hours and 30 minutes. To find the moon's new position, add the amount of change to the original position — 2 hours and 25 minutes plus 4 hours and 30 minutes equals 6 hours and 55 minutes. Look at the star chart and find the "nav star" that is closest to this position and is in the zodiac. (The nav stars have circles around them and numbers next to them.) The correct answer would be Nav Star #39.*

When you are sure that the students understand the procedure, distribute the worksheets and offer help as needed. Conclude the lesson by reviewing the correct answers, offering demonstrations when necessary to clarify misunderstandings encountered.

## Coordinates Worksheet



Systems of coordinates are used to locate positions. On Earth, maps may use a system of coordinates such as latitude and longitude to mark the positions of cities. On street maps, a system of coordinates using letters and numbers may be used to mark the position of streets. In the sky, a system of celestial coordinates called right ascension and declination is used to mark the positions of objects.

In all cases listed above, the coordinate systems involve two measurements. One measurement tells you how far "up and down" to go from some beginning point, and the other measurement tells you how far "side to side" to go from some beginning point. Using both coordinates allows you to find the desired spot. Because coordinates are so important, you will have various opportunities to practice using them.

### Coordinates Exercise #1

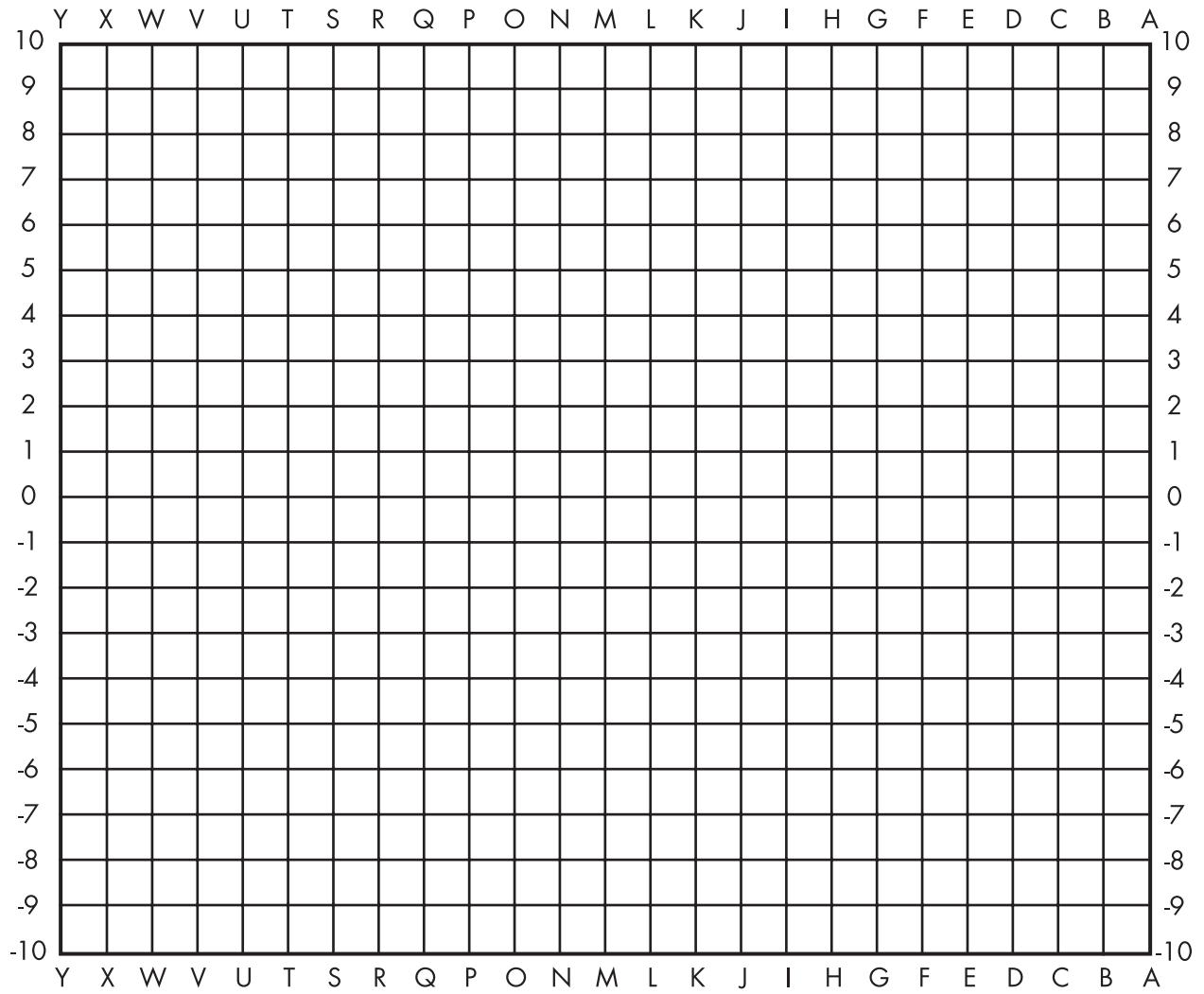
Using the graph on the next page, try to solve the following problem:

1. Locate each of the points listed and label them with the corresponding number.
2. Starting with the point labeled #1, draw a line connecting the points together in order.
3. Identify the object and check with your other team members. Were any mistakes made? Did anyone mark a point "+" when it was supposed to be "-"? How did this change the result?

Point	Coordinates	Point	Coordinates
#1	L -2	#10	D +1
#2	V -2	#11	D -2
#3	V -1	#12	E -1
#4	R +2	#13	E -2
#5	G +2	#14	F -2
#6	F +5	#15	F -1
#7	E +5	#16	D -5
#8	E +2	#17	N -1
#9	E 0		

Name \_\_\_\_\_ Date \_\_\_\_\_

### Graph for Coordinates Exercise #1

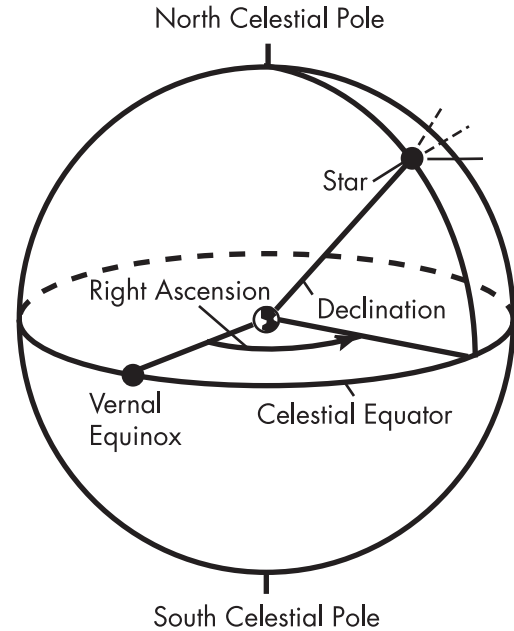


## Coordinates

Systems of coordinates usually involve two or three measurements. In the case of latitude and longitude there are two measurements. One measurement tells you how far up or down to go from some beginning point and the other measurement tells you how far side to side to go from some beginning point. A similar system is used to find objects in the sky.

The celestial coordinates system is based on an imaginary ball of stars around the Earth called the celestial sphere. This sphere has certain points from Earth superimposed upon it. For example, the celestial equator is an extension of the Earth's equator, the north celestial pole is an extension of the Earth's North Pole, and the south celestial pole is an extension of the Earth's South Pole. Declination is measured north or south of the celestial equator (an up-and-down measurement) in units called degrees. Right ascension is measured around the celestial sphere (a side-to-side measurement). It is usually measured in units called hours and minutes but will sometimes appear in degrees.

On Earth, maps may use a system of coordinates such as latitude and longitude to mark the positions of cities. On street maps, a system of coordinates using letters and numbers may be used to mark the position of streets. In the sky, a system of celestial coordinates called right ascension and declination is used to mark the positions of objects. Because coordinates are so important, you will have various opportunities to practice using them.



### Coordinates Exercise #2

Using the celestial map on the next page, locate the following stars and put a circle around them. Number 1 has already been done for you.

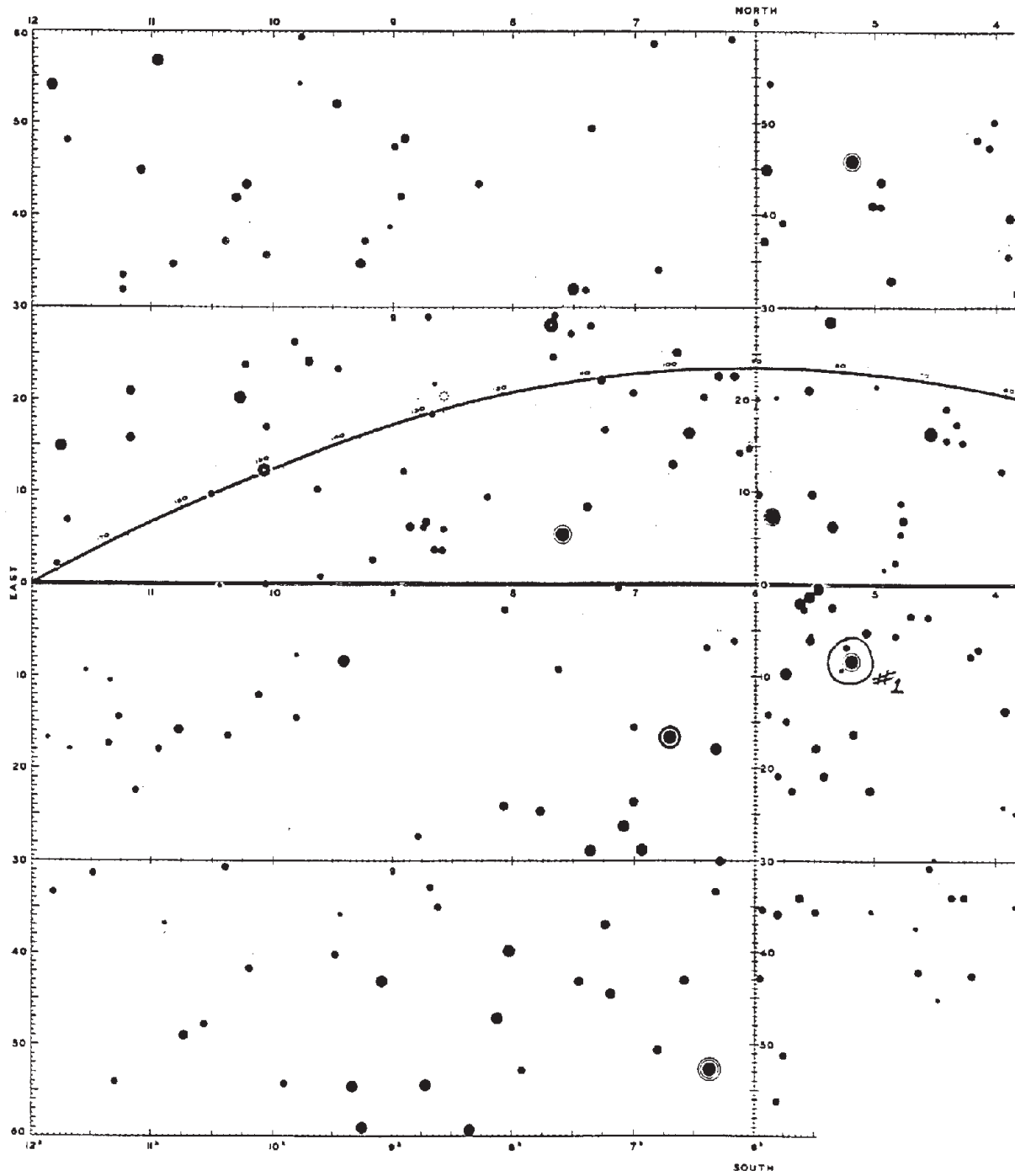
Right Ascension	Declination	Right Ascension	Declination
05 hours 12 minutes	08° S	10 hours 08 minutes	12° N
07 hours 36 minutes	05° N	04 hours 32 minutes	16° N
06 hours 44 minutes	17° S	05 hours 52 minutes	07° N



Name \_\_\_\_\_

Date \_\_\_\_\_

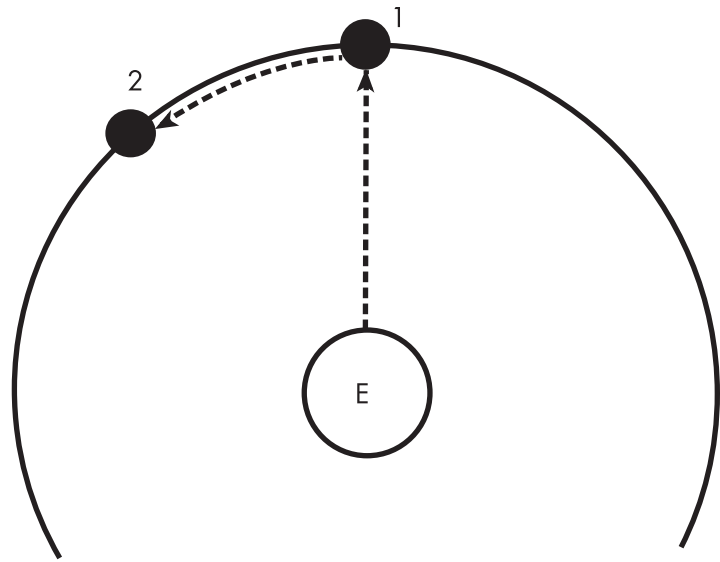
### Celestial Map for Coordinates Exercise #2



### Coordinates Exercise #3 — Navigation Stars

Astronauts use nav stars (navigation stars) for space navigation. They are trained to identify various starfield patterns and the navigation stars that are found within the patterns. The navigation stars can be used to help determine one's current position in space or to help chart a course to a different location. Charting a course to a body in space is no easy matter, especially since, in space, things are always moving!

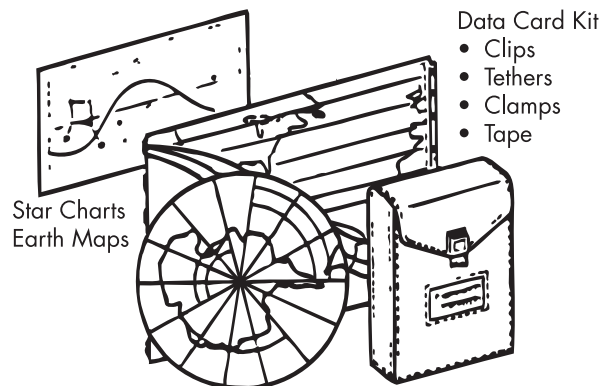
Take the example of the moon. If one were to leave from the Earth on a trip to the moon, and charted a course directly towards the moon on the day of departure, the ship would never reach the moon! As shown in the drawing, by the time the ship reached the correct distance to the moon, the moon would have moved in its orbit around the Earth and would no longer be in the same place! In order to reach the moon, the navigator must be able to predict the future position of the moon for the time that it will take to reach the proper distance, and then chart a course to that predicted position by determining the nav stars in that area.



#### Navigation Problems

Using the accompanying star chart, answer the following questions.

- Given that the moon moves eastward through the zodiac at the approximate rate of 54 minutes of right ascension per day, determine the following information for each of the situations below:
  - The name of the starfield (constellation) for the position of the moon for the first date given.
  - The approximate position of the moon as measured in right ascension (using the units of hours and minutes) for the day of arrival.
  - The appropriate nav star to use for the trip (the one closest to the predicted position of the moon for the arrival date). List the nav star's number.
- Your ship departs Earth's orbit on April 10. The moon is located at 4 hours 45 minutes. Your expected arrival date is April 16.
  - (Constellation name)
  - (Position in right ascension)
  - (Nav star)
- Your ship departs Earth's orbit on June 2. The moon is located at 2 hours 50 minutes. Your expected arrival date is June 6.
  - (Constellation name)
  - (Position in right ascension)
  - (Nav star)
- Your ship departs Earth's orbit on July 2. The moon is located at 5 hours 35 minutes. Your expected arrival date is July 8.
  - (Constellation name)
  - (Position in right ascension)
  - (Nav star)



### Star Chart for Coordinates Exercise #3 — Navigation Stars

