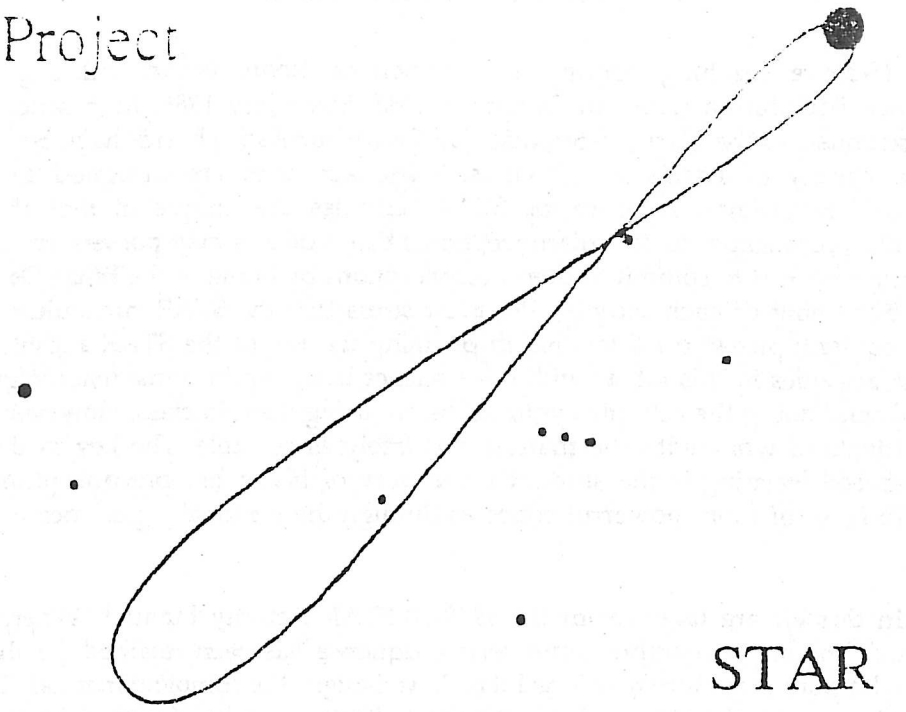
#654-0040 (PS-03) Sun Hemisphere Kit



Science Teaching through its Astronomical Roots

Sun Hemisphere Kit
Teacher's Notes and Activities

Abstracted from the Project STAR activity book, Where We Are in Space and Time.

Project STAR Activities

Project STAR (Science Teaching through its Astronomical Roots) began with a grant from the National Science Foundation (NSF) in December 1985. Since July 1986, high school astronomy teachers and scientists at the Harvard-Smithsonian Center for Astrophysics have been developing and testing a variety of hands-on activities. These activities are designed to teach basic astronomical and mathematical concepts. STAR activities are unique in that they take into consideration the preconceptions (or misconceptions) that students may possess on entering your course. Students are asked to commit to their preconceptions by filling in the What Do You Think? section at the beginning of each activity. We must stress that the STAR curriculum emphasizes concepts over content; please consider this in planning the use of the STAR activities you have purchased. The activities in this kit, as with most science labs, require some teacher guidance. We strongly recommend doing the activities yourself before using them in class. However, you should allow your students to work with the materials as freely as possible. The key to the success of preconception-based learning is the student's discovery of his or her preconceptions and their abandonment in favor of more powerful concepts through the personal experience offered by the activities.

The activities in this kit are taken from the 1989-90 STAR Activity Manual "Where We Are in Space and Time." The original activity numbering sequence has been retained for the benefit of those teachers who purchase more than one kit or have bought the complete manual. The activities should be done in numerical order to obtain the most effective results. You may have found some "extra" activities in your kit; these were included because we felt that they would provide important experiences in support of the principal activity you ordered. Please read the Teacher's Notes for the kit for specialized instructions, answers to questions, tips, and other information. You have permission to make as many photocopies of the activities in the kit as you need for your classes. Permission for any other use of the materials in this kit must be requested in writing on your school stationery and mailed to:

STAR Activities
Center for Astrophysics
60 Garden Street, MS-71
Cambridge, MA 02138

Questions concerning activities can be sent to the address above. Inquiries about orders must be sent to:

SCIENCE FIRST
86475 GENE LASSERRE BLVD
YULEE, FL 32097

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TEACHER'S NOTES - PROJECT STAR - SUN TRACKING HEMISPHERE KIT

Activity 3: Plotting The Daily Motion Of The Sun

1. Preconceptions

Questions 3.1-3.5 constitute the What Do You Think? section of Activity 3. These questions ask what the student believes about the path of the Sun across the sky on a given day, including directions of sunrise and sunset and the number of hours of daylight. Most students think that the Sun rises due east, passes directly overhead at noon, and sets due west. The path plotted for 3.1 is therefore often a simple arc from east, through the zenith, and down to the west. The idea that the Sun is overhead at noon, regardless of the time of year, is very strongly held among students of all ages and academic backgrounds. Expect a number of students to state 12 hours for 3.5; others may be more aware that the days have been getting longer or shorter and respond with values more or less than 12 hours. This activity will directly test these ideas for the date the activity is done.

2. Activity Tips

The plastic hemispheres are quite durable; they may dimple if too much pressure is applied with the marking pen, but the dome will easily pop back into shape.

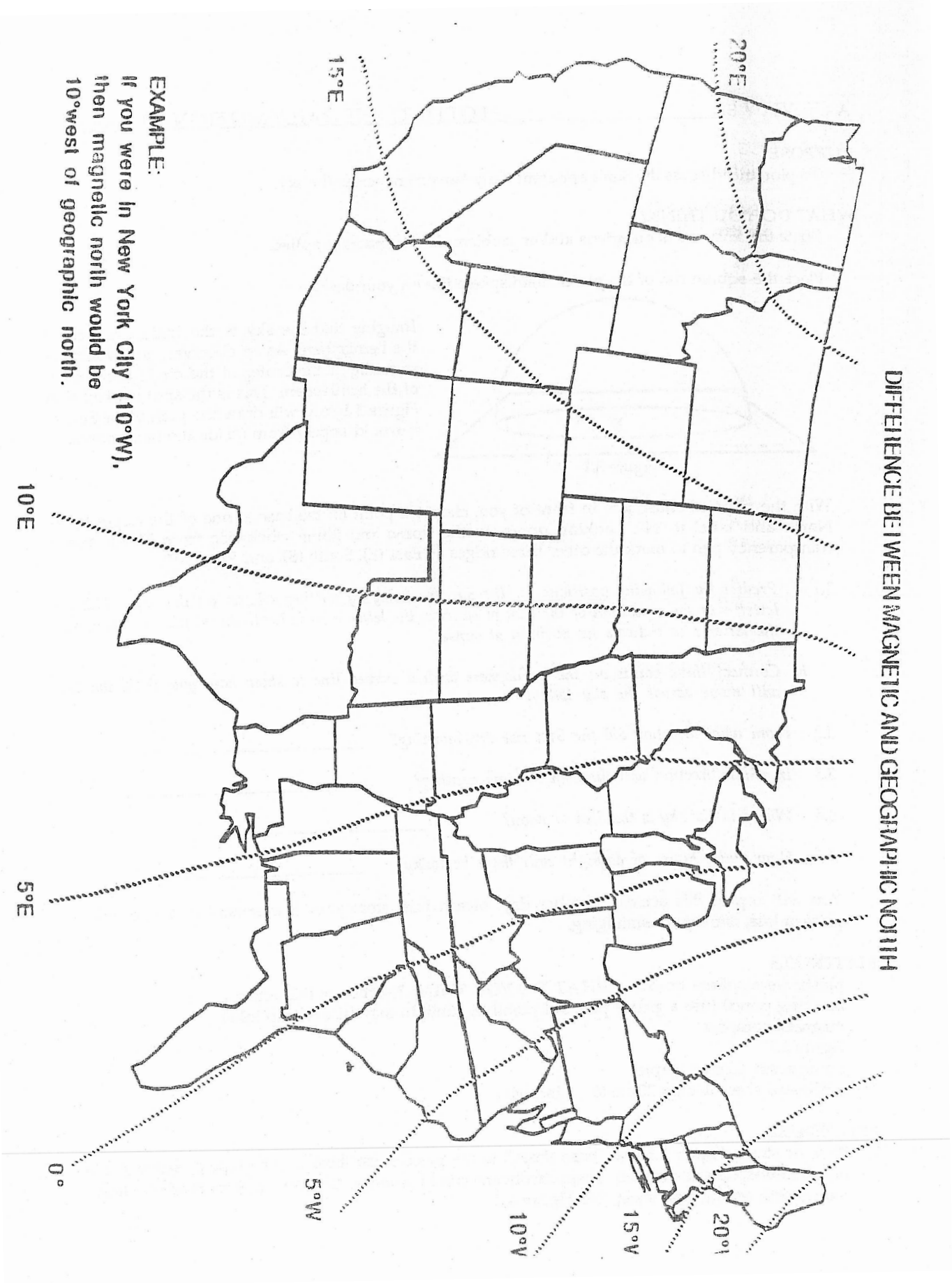
Depending on the size of your class, schedule, and access to an area where the hemispheres can be set out on the ground, you may wish to vary Step 3. As written, the plotting portion of the activity is designed to be completed in one period. However, if you can leave the hemispheres in place for a day, you may have different classes plot positions over the day, or arrange to have students come back during study periods or lunch to continue the plotting. This would be similar to doing Extension 2 in school.

If you are going to be plotting paths for selected days over a period of time (such as Extension 3), you may want to use a grease pencil instead of a felt-tip marker; many felt-tip inks fade on this plastic over a period of days or weeks. If you have time, you might want to experiment with your felt-tips to see how fade-resistant they are.

Note that the alignment of the hemispheres by magnetic compass should take into account the magnetic declination at your location. A declination map for the continental United States is appended to these notes for your reference or to be photocopied for student use.

3. Answers to Questions

The answers to Questions 3.6-3.9 will vary with the time of year and your location. For Question 3.8, the answer should be close to due south, and not directly overhead. By definition, the Sun is directly south at local apparent noon. However, local noon usually does not coincide with 12 noon by the clock due to factors such as daylight savings time and your position east or west of the central meridian of your time zone. (The time zone meridians, or longitudes, for the continental U.S. are: Eastern = 75 degrees West, Central = 90 degrees West, Mountain = 105 degrees West, and Pacific = 120 degrees West. Find your longitude on a map or in an atlas. If you are east of your zone's meridian, the Sun will be at its noon position before 12:00 standard time; if you are west of the meridian, local noon will occur after 12:00 standard time.) At local noon the Sun is also at its highest point in the sky for the day, but it is never directly overhead at noon (or at any other time) for any location in the continental U.S. Only locations on or between the Tropics of Cancer and Capricorn, 23.5 degrees North and South latitude respectively, ever see the Sun exactly overhead, and then only on two days out of the entire year (one day on the Tropic lines).


DIFFERENCE BETWEEN MAGNETIC AND GEOGRAPHIC NORTH
EXAMPLE:
If you were in New York City (10°W),
then magnetic north would be
10°west of geographic north.
20°E
15°E
10°E
5°E
0°
5°W
10°W
15°W
20°W

ACTIVITY 3 PLOTTING THE DAILY MOTION OF THE SUN

PURPOSE

To plot and discuss the Sun's apparent daily movement across the sky.

WHAT DO YOU THINK?

Write the answers to questions and/or problems in the spaces supplied.

Place the square rim of the plastic hemisphere flat on your desk.

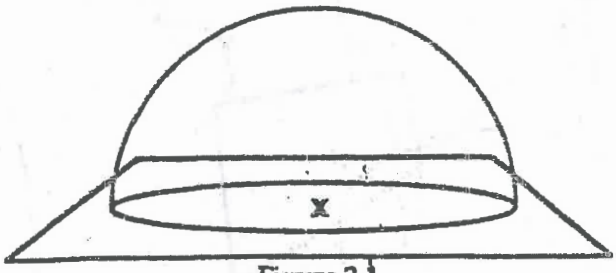


Figure 3.1

Imagine that the sky is the inside surface of the hemisphere. As an observer, you would be standing at the center of the circle at the base of the hemisphere. This is the spot marked X in Figure 3.1. You will draw the path of the Sun as it would appear from inside the hemisphere.

With the plastic hemisphere in front of you, choose a point on the base at one of the ridges to be North and label it "N". Looking down on the dome and going clockwise from North, use a transparency pen to mark the other three ridges as East (E), South (S), and West (W).

3.1 a) *Predict the following positions for the Sun for today by writing a letter on the dome. Use the letter r to show position of the Sun at sunrise; the letter n to indicate its position at noon; and the letter s to indicate its position at sunset.*

b) *Connect these points on the hemisphere with a curved line to show how you think the Sun will move across the sky today.*

3.2 *From what direction did the Sun rise this morning?* _____

3.3 *In what direction will the Sun set this evening?* _____

3.4 *Where in the sky is the Sun at noon?* _____

3.5 *How many hours of daylight will there be today?* _____

You will repeat this activity another day. Meanwhile, store your hemisphere in a safe place to prevent loss, damage, or smudging.

MATERIALS

plastic hemisphere from the WHAT DO YOU THINK? section of this activity
marking pencil (use a grease pencil if possible; sunlight may fade felt-tip inks)
magnetic compass
Figure 3.3
transparent tape or stapler
cardboard sheet 20 cm x 20 cm (8 x 8 inches)

PROCEDURE

1. Tape or staple Figure 3.3 (the "base sheet") to the piece of cardboard. Then tape or staple the base of the hemisphere to the base sheet-cardboard combination so that the ridge marked "N" lines up with North on the base sheet. See Figure 3.2.

2. Place the hemisphere on a flat, horizontal surface in direct sunlight. With the aid of a magnetic compass, turn the hemisphere so the ridge marked "N" points North. NOTE: Be careful not to place your hemisphere near iron or steel objects since these metals will attract your compass needle and produce an inaccurate reading. Once the dome is set in place DO NOT MOVE IT! (Draw an outline around the cardboard with a piece of chalk just in case the hemisphere is accidentally moved.)

DO NOT STARE AT THE SUN. IT CAN DAMAGE YOUR EYES.

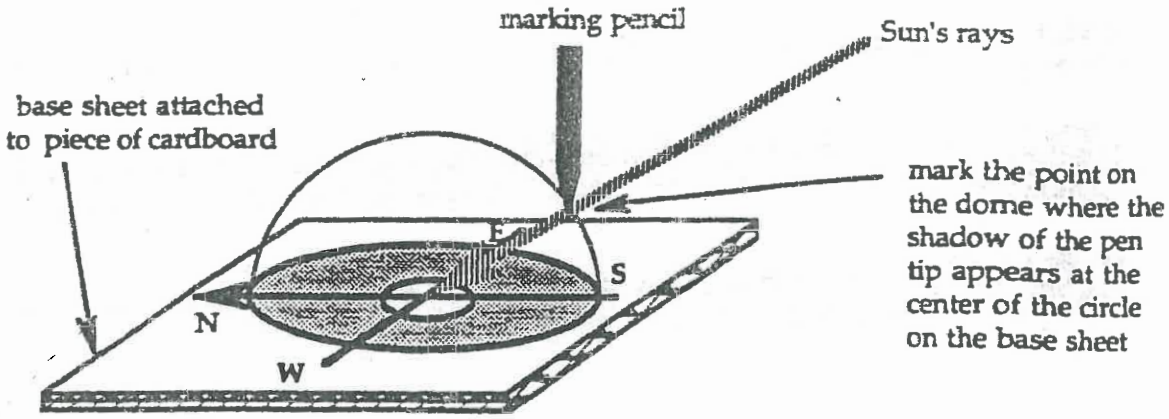


Figure 3.2

3. Plot the Sun's position in the following way (see Figure 3.2):

   a) Carefully move the tip of the grease pencil close to the plastic hemisphere, but do not let the pencil touch the sphere.

   b) Move the pencil around until the shadow cast by its tip falls directly on the + mark on the base sheet.

   c) Touch the pencil tip to the dome and make a dot. The dot's shadow should fall directly on the + mark on the base sheet.

   d) Repeat Steps (a) - (c) every 10 minutes for at least 30 minutes and longer if possible.

   e) Connect the plotted points with a line. Draw this line on the inside of the hemisphere. Label the line with the date and time range. DO NOT ERASE THIS LINE.

DISCUSSION QUESTIONS

3.6 *Discuss how the points and line you drew for Question 3.1 compare with the points and line plotted in this activity.*

3.7 *From what direction did the Sun rise?* _____

3.8 *Where in the sky was the Sun seen at noon?* _____

3.9 *In what direction did the Sun set?* _____

When you have answered these questions, erase the line you drew for Question 3.1. Keep the line you plotted in step 3.

EXTENSION

1. Bring the hemisphere and a magnetic compass home on the same day you did this activity. Follow the set-up and plotting procedures described in Steps 2 and 3. Plot the Sun's motion across the sky for half an hour before sunset and for half an hour after sunrise the next morning. (You will have to wait a day if the sky is overcast at sunset or sunrise.) Label the lines with the dates and time ranges.

2. On a clear weekend day follow Steps 2 and 3 for the entire day. Plot the points at ONE HOUR intervals only.

3. Repeat this plotting of the Sun's daily motion on a clear day one month after the date of your original plot. Repeat this plotting for as many months as possible. Use a different color pen for each month.

4. Refer to an almanac or a calendar to determine the first day of each season. Plot the daily motion of the Sun on the hemisphere for these days. Use a different color pen for each day.

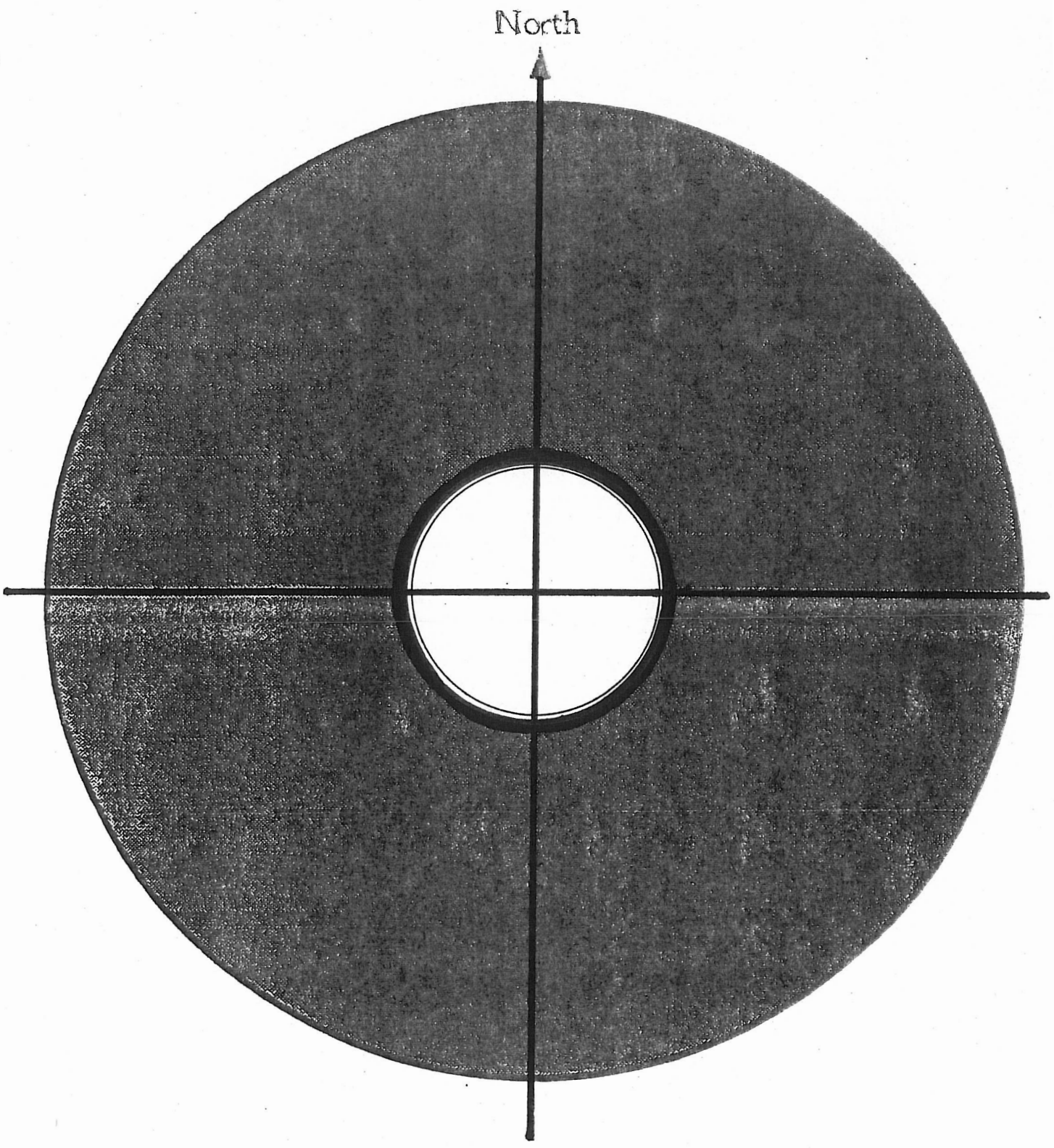


Figure 3.3 Hemisphere Base Diagram