Making Astronomical Observations

We will utilize skills developed in Astronomy With a Stick (AWS) to enable students to make independent observations of the night sky. Activities on the playground will prepare students to locate and record north on their horizon and later use this information to locate the North Star.

History

The mathematics used unit and in the following units is based on systems devised by ancient astronomers and mathematicians. Students will find that all of the measurement systems used in these units are based on multiples of 6 (6, 24, 60, 360). The Sumerians, Egyptians, Babylonians and other ancient people thought that the year consisted of 360 days. The Sumerians devised a number system based on the numbers 6 and 60:

$$6 \times 60 = 360$$

The Babylonians divided the day into 24 hours, each hour into 60 minutes, and each minute into sixty seconds:

1 day = 24 hours = 1440 minutes = 86400 seconds

We use this mathematical system today to determine longitude and latitude, altitude and azimuth, and right ascension and declination. Today we can locate ships at sea and cities on land using these systems.

Student Journals

Students should begin their work on Unit One by preparing their journal, which will be used throughout the Day Into Night activities. The journals do not have to be fancy (plain paper stapled together or simple composition notebooks should work), but students should understand that these journals will be very important in the data keeping process. All scientific observations, data, and questions and answers dealing with these activities should be kept in the student journals.

This Unit in Brief

This unit requires that a compass rose be built on your playground. You can do this as a class or by your self before class. Instructions for this can be found on the NSTA website.

This unit consists of five activities. Through the course of these activities students should follow this sequence of development:

1. Review the cardinal points of the compass

2. Review the longitude and latitude
3. Learn standards for astronomical observation
4. Construct a simple "star map"
5. Use a drawing compass and a protractor
6. Learn some history of mathematics

Activity 1

Objective

In order to establish a reference frame, have your students construct and use a compass rose to locate fixed objects on the horizon. Finding the azimuth for these common place objects (trees, slides, buildings, and so on) will help orient your students to the idea of seeking an astronomical object's azimuth.

Materials

- Writing utensil (pencil suggested)
- Clipboard
- Recording paper
- Journal
- Compass rose constructed on the playground

Vocabulary

- Azimuth
- Cardinal points
- Clockwise
- Compass rose
- Horizon

Procedure

1. Examine the recording paper with your students (for data keeping purposes, students should staple their recording papers into their notebooks after they have filled them out).
2. Go outside.
3. Position the students in small groups at the cardinal points of the compass rose facing the horizon.
4. Have the students move around the cardinal points and record what is visible on the horizon at each point (on their recording papers).

Discussion

Students should share and discuss their observations once you return to the classroom. They may identify fixed objects on their recording papers and compare them.

What would be a good fixed point on the horizon to use here?

Journaling

In addition to their observations, students should answer the following questions in their journals, and be prepared to discuss them as a class.

1. How can the fixed objects on the horizon be used as points of reference?
2. Could a fixed point on the north horizon be identified?
3. How could this point be determined other points of the compass
4. How could a predetermined fixed point on the northern horizon help you find due north at night as well as in the day time?

Connections

The North Star is a fixed point in the sky, and can be used as a reference point to determine the locations of other astronomical objects such as constellations, planets, and so on. Can your students connect this to the definition of azimuth?

After this lesson, students should be able to:

1. Identify the cardinal points of the compass;
2. See how fixed objects on the horizon can be used to identify the locations of other objects.

Conclusions

North on the horizon is always the same direction for every observer. What one sees on the horizon depends on where one is observing.

Fixed objects on the horizon can be used as reference points to determine the location of other objects.

Activity 2

Objective

Students will prepare materials to be used to record the positions of objects viewed at 15 degree intervals on the meridian.

Materials

- Writing utensil
- Journal
- Drawing compass
- Protractor
- Ruler

Vocabulary

- Circumference
- Bisect
- Meridian
- Zenith

Procedure

1. Instruct your students to draw a large 180 degree arc on a piece of cardboard using a drawing compass, protractor, and ruler.
2. Have your students mark one point of the arc 0 degrees and the opposite 180 degrees.
3. Divide and label the arc every 15 degrees using the protractor and ruler. This arc will be used as a recording device in the next activity.

Discussion

Students should answer the following questions in their journals and be prepared to discuss them as a class.

1. How does this recording device resemble a longitude/latitude grid?
2. How do you think that such a grid could be projected onto and used to measure positions of objects in the night sky?
3. How do you think it might be used to locate objects in the sky? Fixed objects on the horizon can be used as reference points to determine the location of other objects.

Activity 3

Objective

Students will be introduced to the concept of altitude by visualizing a 180 degree arc projected into the sky.

Materials

- Writing utensil
- Journal

Vocabulary

- Altitude
- Arc
- Azimuth
- Degrees (as a unit of measurement)
- Fixed object
- Solar noon

Mathematics

In the world of mathematics two types of measure are commonly used. Linear measure measures distances between two objects. If you've used a ruler you are familiar with linear measure. Angular measure is based on a circle of 360 degrees. For example, 90 degrees would be 1/4 of a circle.

Procedure

1. Move students to the playground and have them form in groups at the cardinal points of the compass rose. Have the students face north (using the compass rose and the reference point determined in Activity One).
2. Have your students outstretch their hands so that they are pointing to north on the horizon. Lead your students in swinging their hands overhead to the zenith and on to the south point of the horizon (describing the arc of 180 degrees.) Have your students look at their recording devise from Activity Two and recognize that the arc they have just traced is the same as the one that they had created on paper.
3. Have your students draw what is they see at the northern horizon, the zenith, and the southern horizon. Warn your students that they will not see a lot at the zenith.

Caution! Warn your students to never look directly at the sun!

Discussion

Students should share and discuss their observations once you return to the classroom. They may identify fixed objects on their recording papers and compare them.

Student Journals

Students should answer the following questions in their journals and be prepared to discuss their answers in class.

1. What systems of measurement do you use to measure positions on the earth? (Examples are miles, latitude, and longitude.)
2. What words could you use to describe the position of the sun in relation to you?
3. Is the sun ever at your zenith where you live?If no, why not?
4. Can you imagine a system like longitude, latitude in the sky?

Connections

Help your students connect the ideas of longitude and latitude to the idea of altitude and azimuth by asking them the following questions.

1. If you were standing at the equator, which is marked 0 degrees at the east and at the west, at which degree would you be able to correctly mark your zenith?
2. How would you defend your reason for doing so?
3. Using the altitude/azimuth system of measurement at what degree would the sun be at solar noon?

Homework

Have your students go outside at home tonight or on the first clear night and record what they see at their zenith in their journals. Have them record the date and the time, and discuss what they saw.

Activity 4

Objective

In this activity students will bring together what they learned in the previous activities to identify objects on the horizon and in the sky overhead.

Materials

- Writing utensils
- Journals

Vocabulary

- Degrees
- Horizon
- Zenith

Procedure

1. Position your students in small groups at the cardinal points of the compass rose on the playground.
2. From each point, have your students record what they see from their horizon and at intervals of 15 degrees until they reach the zenith. They should use their recording device from Activity 2 as a guide when determining the angles.
3. Have your students rotate around the cardinal points of the compass rose until all directions have been observed and recorded.

Discussion

When you get back to the classroom, ask your students to use their drawing to answer the following questions.

1. What are some of the objects you saw?
2. Were the objects stationary or moving?
3. What kinds of objects were stationary?
4. What kinds of objects were moving?

Student Journals

Students should answer the following questions in their journals and be prepared to discuss their answers in class.

1. Was the moon visible?
2. If so in what direction did you see it and at what degrees on your recording device?
3. Did everyone in your class see the same things at every location?

Connections

At this point it may be helpful to your students if you review the definitions of altitude and azimuth again.

Altitude: an angle, not a distance or height. It is the angle that is measured from the edge of the horizon along a great circle that passes through the zenith or point directly overhead. It is always 90 degrees or less.

Azimuth: the compass rose goes around through the east through 360 degrees. The azimuth is the angle of the compass rose around the horizon from the north pole through the east, south, and

west to the north again. Ask your students which measurements they made were measuring altitude and which were measuring azimuth.

Homework

On the first clear night, have your students go on to Unit I Activity 5.

Activity 5

Objective

For homework, students will observe the night time sky in much they same way as they did during the day.

Materials

- Writing utensils
- Journals
- Magnetic compass
- Recording device from Activity 2
- Flashlight which has been prepared for night time viewing

Methods Review

Students should review techniques for night-time observation before starting this activity.

Vocabulary

- Magnetic compass
- Zenith

Review

The needle of a magnetic compass will not point exactly to the North Pole. This is because the needle point to the north pole of the Earth's magnetic field. This north pole is different from the geographical North Pole at the top of the Earth. Although the needle will not point to the North Pole that was determined in previous activities, its okay to use it in this activity.

Procedure

This activity is meant to be done as homework.

1. Instruct your students to use a magnetic compass to locate north on their horizon.

2. Have the students use the recording device they constructed in Activity 2 to record what they see in the night sky by drawing what they see every fifteen degrees until they reach the zenith.
3. Instruct your students to staple their drawings into their journals.

Discussion

Ask your students to use their drawing to answer the following questions.

1. Did you recognize any stars that you knew?
2. Did you see the moon?
3. Did you observe alone or did someone help you? Could you observe alone?

Student Journals

Students should answer the following questions in their journals and be prepared to discuss their answers in class.

1. Why was locating due North important?
2. Why did you need a magnetic compass?
3. How did the recording device help you?

Connections

Star charts are maps to the night sky for a particular date and location. (Due to the Earth's rotation around the sun, the stars appear to move across the sky.) By drawing what they see in the sky, students have created their own star charts for their location on that particular date. In future lessons, they will use prepared star charts to locate specific stars and constellations.

Source: http://www.nsta.org/publications/interactive/aws-din/din.aspx