

SNC1D/1P The Study of the Universe/Space Exploration

Student Activity: Using a Mariner's Astrolabe

Topics	Timing
locating celestial objects making altitude and azimuth observations using an astrolabe	preparation: 25 min (to explain use of astrolabes) activity: 15–20 min

Specific Expectations

SNC1D

A1.2 select appropriate instruments (e.g., sampling instruments, laboratory glassware, magnifying lenses, an electroscopes) and materials (e.g., ebonite rods, star charts, a ball and spring apparatus, pH paper) for particular inquiries

A1.6 gather data from laboratory and other sources, and organize and record the data using appropriate formats, including tables, flow charts, graphs, and/or diagrams

D2.2 use direct observation, computer simulation, or star charts to determine the location, appearance, and motion of well-known stars and other celestial objects that are visible in the night sky (e.g., the stars Polaris, Sirius, Betelgeuse; the planet Venus) [PR, AI]

SNC1P

A1.2 select appropriate instruments (e.g., soil sampling instruments, a pneumatic trough and test tubes, magnifying lenses, an electroscopes) and materials (e.g., ebonite rods, star charts, oxygen testing splints, pH paper) for particular inquiries

A1.6 gather data from laboratory and other sources, and organize and record the data using appropriate formats, including tables, flow charts, graphs, and/or diagrams

D2.2 investigate patterns in the night sky (e.g., constellations) and the motion of celestial objects (e.g., the sun, our moon, planets, stars, galaxies), using direct observation, computer simulations, and/or star charts, and record the information using a graphic organizer or other format [PR, AI, C]

Introduction

An astrolabe illustrates how the sky looks at any given time of day and throughout the year. This is accomplished by drawing the sky (star patterns) on the astrolabe with moveable parts to adjust for the date and time. The traditional sky map astrolabe allowed people to locate celestial objects in the sky similar to how a place is located using a map. A mariner's astrolabe is different in that it was used to measure the height or altitude of the Sun or of a star above the horizon. The altitude of a star is the angular height above the horizontal from 0 to 90°. Mariners needed to measure the altitude of the Sun or stars in the sky in order to determine their position. Knowing the altitude of the Sun at noon or of the pole star at night told them their latitude (their distance, north or south, from the equator).

The azimuth of a star is its angular position from north, measured clockwise. For example a star located directly to the north of Earth has an azimuth of 0° , while a star directly to the east has an azimuth of 90° and a star to the northwest has an azimuth of 315° .

Materials

copy of templates: Astrolabe and Astrolabe	thin string (30 cm long)
compass	metal washer
glue	scissors
straw	compass
cardboard or foam board	sharp pencil

Safety Considerations

- Do not look through the straw directly at the Sun.

Procedure

Adapted with permission from UC Berkeley, Space Sciences Laboratory, Center for Science Education. (See link in Additional Resources, below.)

Share the following instructions with students.

Part A: Constructing the Mariner's Astrolabe

1. Glue the "Astrolabe (for altitude)" and "Astrolabe Compass (for azimuth)" templates to a piece of cardboard or foam board.
2. Cut out the two templates.
3. Determine which way is north using a compass or, if aligning at night, using Polaris the North Star. Position the astrolabe compass with N pointing north.
4. Cut the straw to the same length as the astrolabe and glue it on the side indicated on the astrolabe altitude template.
5. Use a pencil tip to poke a hole through the X in the template.
6. Attach the washer (weight) to one end of the string and tie the other end of the string through the hole so that the washer hangs just below the curved edge of the astrolabe. The string should be visible on the side where the measurements are printed.

Part B: Using the Astrolabe

7. Use the astrolabe and compass templates to determine the altitude and azimuth of an object attached to the ceiling from three different points in the room. Record your observations.
 - a. Look at an object in the classroom above eye level. To measure the altitude of the object, close one eye and look through the straw at the object with the other eye. Measure the angle indicated by the hanging string (Fig.1). The altitude is recorded as the angle above a line horizontal with your eye level.



Fig.1 Using an astrolabe to measure altitude

- b. To measure the azimuth of the object, determine its angular position from north using the Astrolabe Compass template. Measure the azimuth from directly over the Astrolabe Compass. Remember that the compass template must be positioned with 0° N pointing directly north.

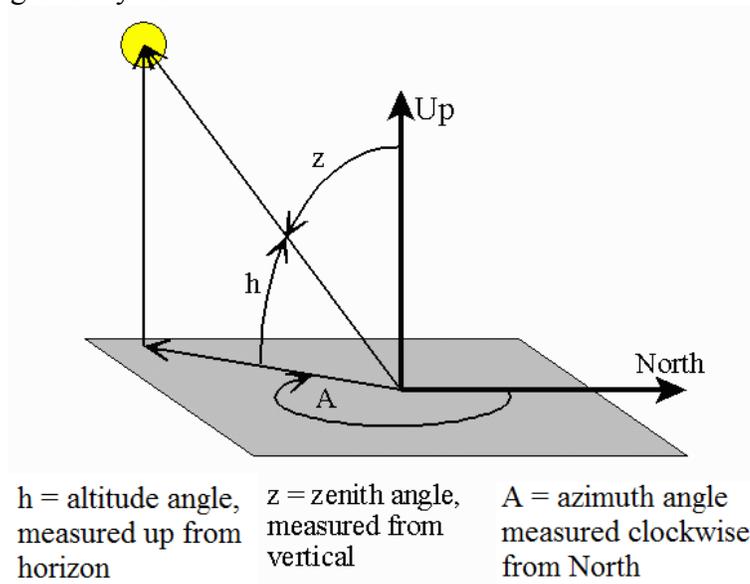


Image courtesy of National Oceanic and Atmospheric Administration

Fig.2 Combining the astrolabe and compass template to measure altitude and azimuth

8. Consider the following questions and, working in small groups, devise your best answers.
- What happens to the altitude and azimuth when you view the same object from different locations?
 - The altitude and azimuth of a celestial object may change over time. What does this tell you about Earth's movement through space? How might the values change throughout the year?
 - Why might two people on different parts of the planet, making altitude and azimuth observations of the same celestial object, record different values?

Disposal

Students could take their astrolabes home. Alternatively the astrolabes may be recycled (if the base is cardboard) or put in the garbage (if the base is foam board).

What happens?

The altitude and azimuth observations of a fixed object will change depending on the location of the viewer.

How does it work?

- When you are further from the object the astrolabe only needs to be slightly angled so the measured altitude is less than when you are closer to the object and it appears higher in your view. The astrolabe in this latter case needs to be angled more and a higher angle (greater altitude) is recorded. Similarly the azimuth may change because, although the orientation of the astrolabe compass does not change, the relative position of the object may change.
- The changes in altitude and azimuth observed in this activity are much larger compared to the changes observed for a star or the Moon over small distances given that this object is very close to the students.

Teaching Suggestions/Hints

1. The object being observed must be centered through the straw to get an accurate reading for the altitude. Each student needs to make his or her own measurements because a student who is 140 cm tall will get a different altitude reading than a student who is 170 cm tall when standing at the same location.

Next Steps

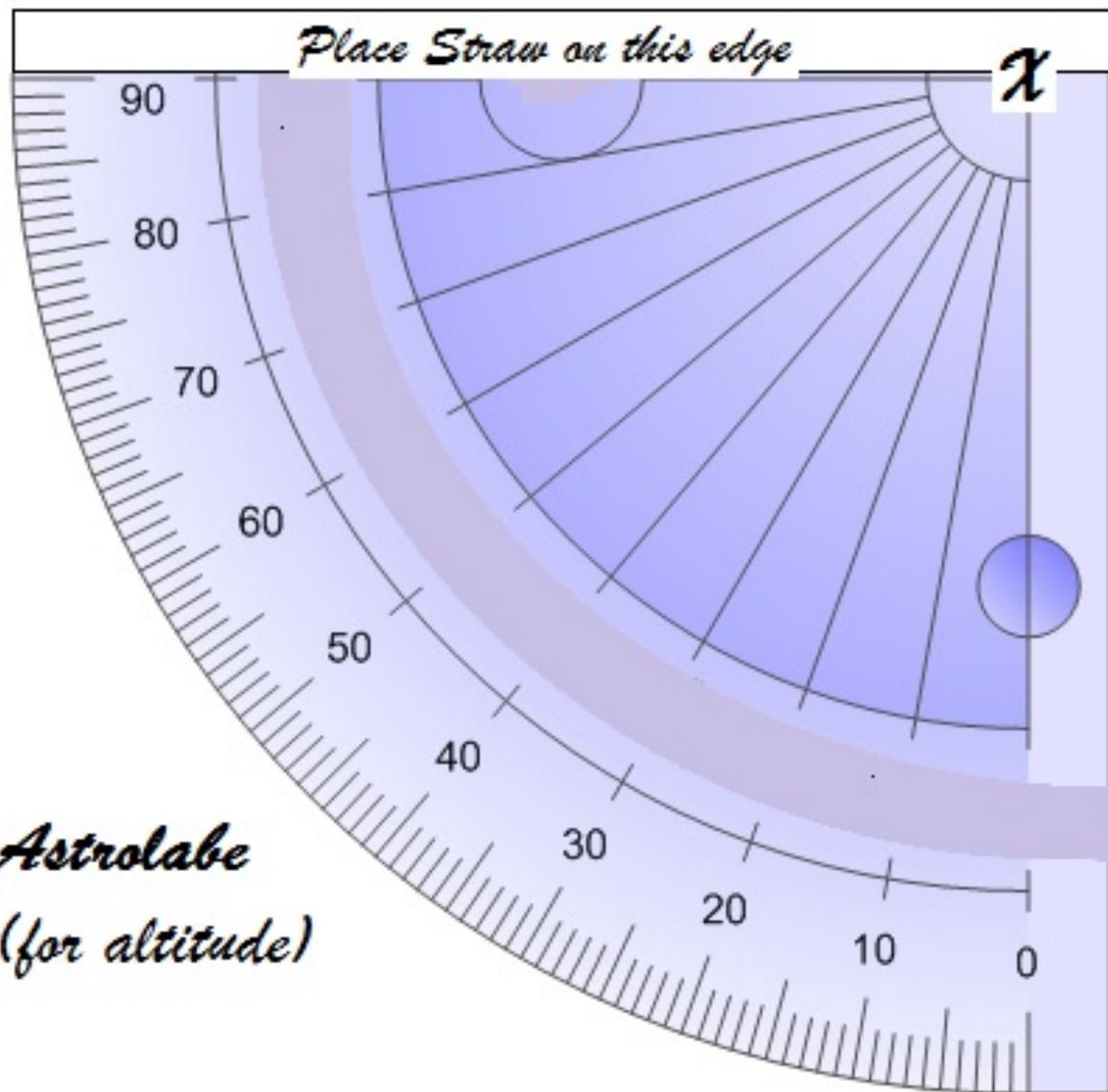
Students could use their astrolabes to collect data observing the change in position of the Moon, Polaris, and other celestial objects in the night sky. Depending on the season you could direct students to observe specific celestial objects, e.g., Jupiter, Betelgeuse, other stars of Orion in the winter. To really detect the motion of Earth, students need to record nightly observations of altitude and azimuth for the celestial objects being investigated at the same time each evening for 5 days.

Extension: Observe and gather data on the Moon for a month and then graph the data to observe trends in the Moon's position over a lunar cycle.

Additional Resources

1. Instructions for the construction and use of a Mariner's astrolabe at:
<http://www.marinersmuseum.org/education/activity-two-students-create-astrolabe>
2. A short history of astrolabes and the locations of various collections of astrolabes at:
<http://www.astrolabes.org/astrolab.htm>
3. At Home Astronomy, UC Berkeley, Space Sciences Laboratory, Center for Science Education – Making a Simple Astrolabe:
http://cse.ssl.berkeley.edu/AtHomeAstronomy/activity_07.html

Template Master



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