Unit 4 The Night Sky

Unit Overview

This unit will introduce the student to constellations, asterisms, light pollution, and the celestial sphere. The celestial sphere is the set of coordinate systems used to map the position of stars and planets in the sky.

Motivation

One of the primary reasons students take astronomy is to learn about the constellations. Unfortunately, learning the names of the constellations is not a major part of many state's learning standards. Therefore this unit is rather short, and builds constellation learning into the scientific process of observations and also connects many interdisciplinary topics such as geometry. Students will be constructing celestial spheres during the unit, and if you build the large 5-meter dome, it will be very exciting for the students to participate.

Lesson Descriptions

Lesson 4-1: Introduction to Constellations

In this lesson students will learn what a constellation and asterism is, draw their own constellation, and learn to operate a planisphere for learning the names of constellations and stars to augment their observing notebooks.

Lesson 4-2: Lines in the sky

Students will construct a small model celestial sphere to learn about coordinate systems in the sky.

Lesson 4-3: Light Pollution

This lesson is centered around a lab activity to measure light pollution as a single observation and as a larger scale activity.

Lesson 4-4: Build a Planetarium

In this multiple-day activity, students build a planetarium and projector large enough to fit a typical class. Then they use it to practice constellations, learn coordinate systems, and also use it as a basis for studying spheres when comparing the size of the sun to the earth and planets in later units.

Lesson 4-1:Introduction to Constellations

Objective

In this lesson students will learn how to identify constellations. Descriptions and pictures are provided for the constellations as a function of the season. Students will also build a simple planisphere or learn to use one they have purchased. Each student will be assigned a constellation report to have them prepare a small poster or powerpoint about one of the 88 official constellations.

Resource List

Activity 4-2: My Constellation
Activity 4-1: Constellation Reports
Lab 4-1: Using a Planisphere
Planispheres are available at most major bookstores. You can also have students make their own from plans posted online at the Lawrence Hall of Science web site: http://www.lhs.berkeley.edu/starclock/skywheel.html
The Lawrence Hall of Science also publishes a set of larger, more versatile planisphere wheels called the Sky Challenger, which does not require assembly.

Skills Attained

After completing this lesson, students will be able to:

- operate a planisphere to identify constellations.
- explain that the motion of the earth turning causes the sun to rise and set, and causes stars and planets to rise and set as well.
- explain that constellations are both historical and cultural records of things important to the people who named them.
- recognize when a constellation appears differently due to the season, the time of day, and the presence of a planet
- find the North Star as an aid to casual navigation.
- define circumpolar constellations.

Vocabulary

constellation, planisphere, asterism, North Star, Polaris

Motivation

Students love to learn about the names of constellations. During a traditional planetarium show, the review of constellations visible in the night sky is often the most popular part of the program. This lesson allows some degree of creative expression as well, as students are asked to invent a constellation as a warm-up exercise and to do a traditional report, not involving experimental design, for the constellation report.

Procedure

This lesson, especially the constellation reports, can take several days. You may wish to present only the introductory material and assign the reports and planisphere practice as homework, at least until you complete the planetarium for your class in a later lesson during this unit.

Activity 4-2: My Constellation

This is basically a warm-up activity for students to use to get the concept that constellations are drawings of things important to the people who made them up. The only problems you may encounter is that some students may come to your class knowing many of the traditional constellations, and so they will not see the point of inventing new constellations other people will not need to learn. However, it is a fun activity and somewhat "lightweight" compared to many other activities in this book and therefore can be a nice change of pace for a few minutes.

You should point out that many of the traditional constellations do not look much like what they represent, while others do; this is because the stories came first, and the constellations where simply reminders of the stories, sort of a precursor writing or drawing. Some of the constellations were named by relatively modern European explorers investigating the Southern Hemisphere; thus we have Telescopium, Microscopium, and so on.

Activity 4-1: Constellation Reports

Immediately following the introduction to the constellations, you can assign the planet reports. These reports can be PowerPoints, posters, or oral presentations. The activity lists a number of characteristics of constellations which can be investigated. The characteristic of greatest importance to the practicing astronomer is the genitive form of the constellation's name, and it's three-letter International Astronomical Unit abbreviation. This is because the official designation of many objects is based on the constellation they are in. For example, using the Bayer system of star designation, the most important star in the constellation is given the name Alpha followed by the genitive (possessive) form of the constellation's name. Thus, Alpha Geminoris is the brightest star in the constellation Gemini. (The 'alpha' star is not always the brightest one, but usually is.)

Since researching and presenting these reports may take several days, you may consider assigning this task during the construction of the large planetarium sphere, so that all students are busy working on something.

Lab 4-1: Using a Planisphere

In this lab students are introduced to a planisphere, which is a circular projection of the celestial sphere onto a flat surface. If you have a clear plastic planisphere with stars painted on it, sold by many science supply stores, then you can demonstrate how a planisphere is made by putting the North Star on top and shining light down on the sphere from above. The flat, projected image of the stars (at least from the top half of the sphere) is what gets projected onto the planisphere). (The actual generation of a planisphere is somewhat more complicated; more than half of the sky is displayed on a planisphere wheel, so constellations below the celestial equator become increasingly distorted.

To do this activity, you will naturally need a planisphere. There are many different planispheres available on the market, and the devices can usually be found in a local mall's bookstore. If none are available, you can have students construct one from scratch using plans on line at the Lawrence Hall of Science (see the Resource List for a link).

The constellation homework (Handout 4-4) is essentially planisphere practice homework.

The most difficult thing students have to learn about planispheres is that you have to do two things at once: Not only must you find the date, you must align the time to it. For some questions, the time an object may rise may not be during the night hours, so students should extend the clock hours all the way around the edge of the planisphere to estimate the time.

Content Background

Planispheres are the basis of the simulation of the sky. They perform the same function as celestial spheres, but in a more limited way. Typically planispheres are designed to represent the sky at some mid-northern latitude. Southern hemisphere planispheres exist but are harder to find.

If you are using a planisphere for a latitude different than where you live, the accuracy of the predicted rise times and directions will be reduced. However, if you are within 5-10 degrees, the differences will be small enough not to matter for casual observing. Constellation identification,considered an important skill for amateur astronomers and planetarium operators, is not required for most professional astronomers. In fact, the old saying that many professional astronomers do not know their traditional constellations is actually true. Most work in professional astronomy does not require an astronomer to go outside to identify the constellation. However, they do need to be able to predict when a target will be visible, so they can know when to request time on a large telescope.

Assessment

Homework is provided for this lesson to practice predicting when stars and constellations will be visible for observing purposes.

Lesson 4-2: Lines in the sky

Objective

In this lesson students will learn some of the basics of celestial coordinate systems. They will build a small celestial sphere and use it to understand the relationship between equatorial, local (alt-az) and ecliptic coordinates.

They will learn the major constellations as a function of the season, and be able to distinguish between constellations and asterisms.

Resource List

Activity 4-3: A Small 1-F Dome
    compasses, scissors, glue, thick paper, ruler, glue
Activity 4-4: Lines in the Sky
    domes from activity 4-3 or clear plastic domes, markers
Lab 4-2: Basic Constellation Observations
    Planisphere
Handout 4-1: Constellation Charts
Handout 4-1: Common Asterisms and Constellations

Skills Attained

After completing this lesson, students will be able to:

- explain the difference between ecliptic and equatorial coordinates.
- explain why altitude-azimuth coordinates of an object in the sky continually change.
- name several circumpolar constellations.
- name several constellations currently visible.
- use charts to determine the location of stars in the sky.
- find the North Star at night without a constellation map.

Vocabulary

Motivation

Many high schools with planetariums conduct outreach programs, where high school students teach students at lower grades how to identify constellations and planets in the sky. Aside from the obvious recruitment effects, this also allows your students to act as good role models for how to behave in a planetarium, which would be appreciated by your local planetarium operator. If students learn their constellations well enough, younger students will arrive at high school asking how they can participate in the planetarium outreach program. If you visit www.AstronomyTeacher.com, you can see some other high schools with astronomy programs, and at the web site www.ESPACEAcademy.com you can find a number of reports on how school-based planetarium programs have been conducted by my students.

Procedure

This lesson consists of several activities designed to assist students in understanding the celestial coordinate system (which culminates in Lesson 4-5.) This is a precursor to that activity. It is also a practical application of geometry.

Activity 4-3: A Small 1-F Dome

This is a simple activity and has the student construct a portion of a dodecahedron (20 sided figure) which, if fully assembled, will create a crude globe or sphere. If the bottom of the dodecahedron is left off (the "5-cap" at the bottom) then a mini-planetarium is formed. These instructions are used again in activity 4-4 where a slightly larger dome is constructed and can sit on top of the first one.

The instructions are fairly straightforward. Some of your students may have done this activity as an art project in elementary school. If they ask if they can make a larger one, tell them plans are just a little farther along in the book.

Activity 4-4: Lines in the Sky

This activity shows the point of making the dodecahedron in the previous activity. Basically, one dome will be constructed to show the alt-az coordinate system. Another dome will be constructed identically, but larger, so it can illustrate the equatorial coordinate system. The idea is that the observer is in the center of the dome, can see through both domes, and can see the lines drawn on each. The point where the ecliptic crosses the celestial equator is the first point of Aries, zero hours of right ascension, and the position of the sun at the beginning of Spring. This is explained rather thoroughly in the workbook, but as a suggested teaching

aid you might consider making an oversized set of domes out of clear transparency material. This will allow you to show students what the device is supposed to look like in a "see-through" design, and especially see the two coordinate system circles (equator and ecliptic) at the same time.

By tilting one dome with respect to another, you can show the view as if the earth had a variety of axial tilts. Having both domes aligned, sitting one on top of the other, would show what the sky would be like if the earth's axis were not tilted. Having the domes aligned at right angles would be similar to the sky around Uranus, where the axial tilt is close to 90 degrees.

There are obviously lots of opportunities for creativity here, as students can decorate the outside portions of the spheres and they can be hung from the ceiling, in anticipation of building the larger cardboard planetarium.

Lab 4-2: Basic Constellation Observations

This activity extends the initial foray into stargazing introduced in Activity 4-1, and asks the student to begin learning constellations visible in the evening sky. Several pages of observing notes are provided, as well as seasonal sky charts generated by Starry Night in the Handout section.

If you do not live in a place where nighttime observing is practical or safe for your students, you can postpone this activity until you have completed the planetarium dome and added a projector; then students can use the simulated sky to learn the constellations.

Handout 4-1: Constellation Charts

These handouts are an observing reference and show the appearance of the sky from a mid-northern latitude, observed around 9 PM, facing south and facing north, around the beginning of each of the four seasons. They have a rather large field of view, so there may be some distortion of the constellation shapes near the edge of the picture.

Handout 4-1: Common Asterisms and Constellations

This is a guide to common constellations and asterisms, plus observing tips such as how to find easy to recognize constellations using ones you know as a guide.