Mauna Kea: Gateway to the Universe
Curriculum Resource
Grades 5-8

Overview

Sigmund Jahn, the first German astronaut, once said, "Before I flew I was already aware of how small and vulnerable our planet is; but only when I saw it from space, in all its ineffable beauty and fragility, did I realize that human kind's most urgent task is to cherish and preserve it for future generations." To think that in a moment this person saw things that we can only see through the eye of a telescope. In this guide, we will look up and beyond to create in students' new ideas and understandings of the night sky.

What do you picture? When we think of the night sky, we usually think of the twinkling stars and the moon guarding earth until the morning sun appears. When we look to the sky, some might even think of the astronauts that have braved the great unknown and have gone "where no man has gone before." But have we ever thought about constellations, the planets or what it takes to see things that are so far away?

Through this Celebrating Science experience, students will see and learn about Mauna Kea on the island of Hawaii and understand why it is called the "gateway to the universe." Students will look at the solar system and explore their place on earth. Students will also learn how to make a telescope, find constellations, and gain an appreciation of the wonders above.

Learning Objectives

Topic: Excursion	Learning Objective(s)
Astronomy: ***Mauna Kea***	**Goal of the Mauna Kea Passports** **TLW** (*The Learner Will)*: **Objectives** **During/After Unit, the learner will be able to...** • arrange planets in order from the sun; • understand the concept of how a telescope works; • compare specific constellations; • explain why constellations were created and their importance to time of year; • comprehend how an understanding of the universe impacts their lives; • write a story based on the writing style of a specific author; and • prepare and give oral presentation in some format to class.

National Standards Addressed

The following are National Standards addressed through basic participation in the journey. Engagement and participation in additional pre- and post-activities (provided below) will expand the scope of standards addressed.

Grades 5 – 8
Language Arts: ***National Reading and Language Arts Standards***
▪ *Standard 1:Reading for perspective* ▪ *Standard 6:Applying knowledge* ▪ *Standard 8: Developing research skills*
Science: ***National Science Education Standards***
▪ *Standard 1: Science Inquiry* ▪ *Standard 4: Earth and Space Science* ▪ *Standard 5:Science and Technology*
Technology: ***National Technology Education Standards***
▪ *Standard 3:Technology Productivity Tools* ▪ *Standard 5 Technology Research Tools*

Grades 5 – 8
Arts: Visual Arts   ***National Art Education Standards***
▪ *Standard 1: Understand and Applying Media and Techniques, and processes*   ▪ *Standard 4:Understanding the Visual Arts in Relation to History and Cultures*
Writing: ***National Technology Education Standards***
▪ *Standard 3:Technology Productivity Tools*   ▪ *Standard 5 Technology Research Tools*

Background Information

Mauna Kea is located about 300 km (190 miles) from the capital city, Honolulu, on the island of Oahu. The highest point in the Pacific Basin, and the highest island-mountain in the world, Mauna Kea rises 9,750 meters (32,000 ft) from the ocean floor to an altitude of 4,205 meters (13,796 ft) above sea level, which places its summit above 40 percent of the Earth's atmosphere. The broad volcanic landscape of the summit area is made up of cinder cones on a lava plateau. The lower slopes of Mauna Kea are popular for hunting, hiking, sightseeing, and bird watching in an environment that is less hostile than the barren summit area.

Hawaii is Earth's connecting point to the rest of the Universe. The summit of Mauna Kea on the Island of Hawaii hosts the world's largest astronomical observatory, with telescopes operated by astronomers from eleven countries. The combined light-gathering power of the telescopes on Mauna Kea is fifteen times greater than that of the Palomar telescope in California -- for many years the world's largest -- and sixty times greater than that of the Hubble Space Telescope.

There are currently thirteen working telescopes near the summit of Mauna Kea. Nine of them are for optical and infrared astronomy, three of them are for submillimeter wavelength astronomy and one is for radio astronomy. They include the largest optical/infrared telescopes in the world (the Keck telescopes) and the largest submillimeter telescope in the world (the JCMT). The Submillimeter Array is currently nearing completion, while the westernmost antenna of the Very Long Baseline Array (VLBA) is situated at a lower altitude two miles from the summit. This information and more can be found at:
http://www.ifa.hawaii.edu/mko/about_maunakea.htm

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Additional Resources
Mauna Kea: This resource provides general information about Mauna Kea.
http://www.ifa.hawaii.edu/mko/visiting.htm

Mauna Kea: This resource provides additional information on Mauna Kea as well as provides links to pictures and information about the 13 telescopes.
http://www.ifa.hawaii.edu/mko/about_maunakea.htm

Astronomy Lesson Plans: This resource provides lesson plan and links to ideas to help in furthering this unit.
http://school.discovery.com/lessonplans/programs/classroomplanetarium/

Windows to the Universe: This resource is a student centered web site that studies the concepts in the Solar System in a fun and engaging way.
http://www.windows.ucar.edu/

Aerial Tour of Mauna Kea Observatories: This resource provides pictures and information about the different telescopes that can be seen in Mauna Kea.
http://www.ifa.hawaii.edu/images/aerial-tour/

Kids Astronomy: This resource provides resources and activities to further the students learning about space.
http://www.kidsastronomy.com/

Windows to the Universe: This resource provides resources and activities to further the students learning.
http://www.windows.ucar.edu

Preparation for the Excursion
To ensure the most meaningful learning experience for your students, it is recommended that students investigate the resources provided and engage in activities prior to the excursion. The video resources provide students with a context for the virtual excursion. The additional resources and activities offer opportunities for curricular connections and integration within your larger unit of study. The excursion is intended to complement a comprehensive unit. During the excursion, classes will be asked to share their response to the challenge question and the expert will provide feedback. It is recommended that your students decide as a class on *one* response to the challenge question.

Video Resources

Mauna Kea: Gateway to the Universe
http://easylink.playstream.com/21_CenturyLearning/journeys/hawaii/mauna_kea.rm

Challenge Question
Why is seeing and understanding elements in space important?

Answers:
The idea is to have the students begin to think and explore how the moon is able to be seen up close. Students will be learning basic facts associated with the observatories of Mauna Kea. By exploring Mauna Kea observatories, students will be able to learn about three basic types of telescopes used to look at the stars.

Activities
I. Getting Started
1. Ask students, "What might you see if you looked in the sky at night?" Give students a chance to discuss their personal experiences relating to this topic. Then ask, "what would you like to learn about space and the solar system?" Record responses on a chart and display the list for future reference. Break the chart into rows displayed vertically to represent the layers of the earth's atmosphere. On each row write one of the following headings: "What I know, What I want to know, What I know now." This chart should be referred to throughout your study.

2. Discuss key terms that will be used throughout the excursion. As these terms will be used throughout the journey, it is advised students understand their meaning before the excursion. (The key terms are listed and defined on the following pages. This will allow you to print and copy the following pages and give to the students as a reference guide. A blank page has also been included for choosing vocabulary words that can then be filled in and used for either a definition work page or vocabulary assessment.)

Key terms Reference Guide

Absolute magnitude: Magnitude that a star would appear to have if it were at a distance of 10 pc from the Sun.

Albedo: Fraction of incident sunlight reflected by a planet or minor planet.

Altitude:

a. Distance above the surface of a planet, used in describing an atmosphere or a spacecraft orbit.

b. Angle of elevation above the horizon, for the line of sight to a celestial object.

Apparent magnitude: The brightness of an astronomical object, as observed on Earth and referred to the appearance of some objects chosen as standards. The scale of magnitudes is defined so that a difference of 5 magnitudes corresponds to a ratio of 100 in observed radiation intensity.

Asteroid: Older name for minor planet. Object in orbit around the Sun, intermediate in size between meteoroids and planets.

Asteroid belt: The region of the solar system in which most asteroids have their orbits, between Mars and Jupiter.

Astrology: A system in which the positions of the Sun, Moon, and Planets are supposed to exert an influence on events on Earth. Originally a part of astronomy, astrology is today without scientific content. Astrology is strictly forbidden in the Bible.

Astronomy: the branch of physics that studies celestial bodies and the universe as a whole.

Binary star: Double star with the two stars in orbit around one another.

Black dwarf: Final state of stellar evolution, when a star has used up all of its energy resources and can no longer radiate.

Black Hole: Body that is so massive and so compact that no light can leave its surface.

Cassegrain: Inventor of a type of reflecting telescope that now bears his name. In this design, light from the concave primary mirror is reflected a second time by a convex mirror, though a hole cut in the primary, to produce an image at the Cassegrain focus.

Comet: Small body in the solar system, in orbit around the Sun. Some of its frozen material vaporizes during the closer parts of its approach to the Sun to produce the characteristic tail, behind the right head.

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Constellation: A group of stars that seemed to suggest the shape of some god, person, animal or object. Now a term used to designate a region of the sky. There are 88 constellations.

Cosmology: The study of the origin and Large-scale features of the universe.

Density: A measure of compactness: mass of an object divided by its volume.

Dwarf: Main-sequence star of low luminosity.

Eclipse: Blocking of light from one body by another that passes in front of it. Eclipse can be total or partial.

Galactic latitude and longitude: System of coordinates useful in specifying the location of objects with respect to the galactic equator (for latitude) and the direction toward the galactic center (for longitude).

Galaxy: Large number of stars with their interstellar gas and dust, grouped into a region that is well separated from other galaxies. (Star clusters occur on scale much smaller than that of galaxies).

Giant: Star with very large luminosity and radius, much more luminous than main-sequence stars with same surface temperature.

Head (of comet): Bright part of a comet, containing the small nucleus and its surrounding coma.

Interstellar dust: Small, solid particles or grains, probably mostly silicates and graphite.

Ionosphere: Outer region of the Earth's atmosphere where many of the atoms have been ionized by the absorption of solar ultraviolet radiation.

Latitude: Coordinate used to measure (in degrees) the angular distance of a point or celestial objects above or below an equator.

Light year: Distance that light travels in 1 year.

Longitude: Coordinate used to specify the position of a point or direction around (or parallel to) an equator.

Magnetic field: Region surrounding a magnet or electric current, in which magnetic force can be detected in such a region, high-speed electrically charged particles will generally move along curved paths and radiate energy.

Magnetic field: Region surrounding a magnet or electric current, in which magnetic force can be detected in such a region, high-speed electrically charged particles will generally move along curved paths and radiate energy .

Magnetic pole: One of the two regions on Earth to which a compass needle will point. Poles also exist on magnets, and the magnetic fields of some electric currents can have an equivalent behavior.

Magnitude: Scale for describing brightness of a celestial object. See apparent magnitude, absolute magnitude.

Meteor: Glowing trail in the upper atmosphere, produced by meteoroid burning up as it moves at high speed.

Meteor shower: Numerous meteors seen in short time span as the Earth moves through a cloud of meteoroids, probably remnants of a comet and still following the comet's orbit.

Meteorite: Remnant of meteoroid that has been partially eroded in passage through the Earth's atmosphere before hitting the surface. Term now also applied to similar bodies that collide with the surfaces of the other planets and their satellites, producing craters.

Meteoroid: Large rock (but much smaller than minor planets) moving in an orbit in the solar system. Meteoroids that enter in the Earth's atmosphere are termed meteors or meteorites, depending on their behavior.

Milky Way: Bright band that stretches across the sky, produced by large number of stars and other bright objects that lie near the equatorial plane of our galaxy.

Milky Way galaxy: Concentration of stars, gaseous nebulas, interstellar gas and dust in which the Sun and solar system are located.

Nebula: Object with nonstellar appearance. Objects originally labeled as nebulae are now known in include galaxies (Andromeda is one), clouds of gas and dust (Orion nebula), and supernova remnants (Crab nebula).

Neutron: Subatomic particle with mass closely similar to that of the proton but carrying no electric charge. A constituent of all atomic nuclei except hydrogen.

Neutron star: Star composed of neutrons except for a very thin surface layer of atoms. Neutron stars have masses similar to the Sun but dimensions not much larger than the Earth, and, as a result, have very high densities.

New moon: Phase of the moon when its motion brings it between the Earth and Sun, and thus appears to us not to be illuminated.

Nova: Abbreviation from nova stella. This is the Latin word for new star, literally meaning the sudden appearance of a star where none had previously been known. Term now applied to sudden large brightening of a star, followed by a less rapid decrease in brightness.

Open cluster: Galactic cluster of stars in which the individual stars can be seen, located within the spiral arm of disk of the galaxy.

Orbit: Path traced out by one object around another.

Phases of the moon: Cycle of variations in the Moon's appearance, produced by the changing Sun-Moon-Earth angle through each month. The result is a regular cycle of changes in the Moon's brightness and apparent shape.

Quasar: Object that appears starlike but its actually extra-galactic, moving away from us at high speed. Distance, deduced from velocity-distance relation, is very large. Extremely luminous.

Red giant: Large star with relatively low temperature but high luminosity; a stage in stellar evolution after a star has left the main sequence.

Reflecting telescope: Type of telescope in which the objective is a concave mirror.

Refracting telescope, refractor: Type of telescope in which the objective is a lens.

Refraction: Bending of light and other electromagnetic radiation in passing from one transparent medium to another.

Rotation: Movement (spin) of a body abut an axis that passes through that body. Distinct from revolution, which is motion in an orbit about some point or other body.

Satellite: Body that revolves in orbit around another body. Planets are satellites of the Sun, the Moon is a satellite of the Earth, and artificial satellites have been sent into orbit around the Earth, Moon, Mars and Venus.

Schmidt telescope: Type of reflecting telescope that uses a spherical primary mirror and a thin correcting lens across the full aperture.

Spectrograph: Instrument for dispersing light into a spectrum and then photographing it.

Spectroscope: Measurement of the intensity of light in various parts of a spectrum.

Spectroscope: Instrument for viewing a spectrum. Usually contains a prism or grating that disperses the light.

Star cluster: Group of stars within a galaxy, either very closely packed (in globular clusters) or further apart (in open clusters).

Stratosphere: One of the upper layers of the Earth's atmosphere, above the troposphere that contains most of the weather, and below the ionosphere.

Sunspot: Area that appears dark on the solar disc because the sunspot has a temperature somewhat lower than its surroundings.

Variable star: Star whose luminosity changes. This designation will include stars with explosive changes (novae and supernovae) as well as cyclic changes (Cepheids and RR Lyrae).

Velocity: Speed in a designated direction. The rate at which a body changes its position is usually designated as *speed,* which the direction of motion is not considered. *Velocity* implies of definite direction.

White dwarf: Star that is less massive than 1.4 times the solar mass, that has consumed almost all of its nuclear fuel and has contracted to a size not much larger than the Earth. This star is characterized by high surface temperature but small luminosity, as compared to the Sun. White dwarfs fall below the main sequence in the H-R diagram.

Zenith: Point on the sky directly overhead.

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Astronomy Key Terms

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II. Classroom Decor

1. Dress up classroom with pictures of Hawaii, Mauna Kea, planets and stars.

2. Split the room into groups labeling each group with the name of a star cluster, planet or telescope (ex. lunar moon, sun, Milky Way or Keck telescope.)

a. Devote a part of a classroom wall to the "All About Astronomy" display. This could include pictures, facts, Astronauts, space shuttle articles and the chart.

3. Display a "space chart." Design a chart that has the name of the student groups listed in space ships. All of the ships will start on earth and slowly move their way through the atmosphere to reach the moon. Use this chart to graph students' behavior. Every time a student is recognized for their good behavior for the day, the name of the team moves farther up into space. Whichever team reaches the moon first gets a class reward. This concept can also be expanded to include the student who reads the most books dealing with Astronomy or related topics.

III. Literature/English

Reading Activity 1:

Activities can be altered to accommodate grade level.

Have the students or a group of students read A Wrinkle in Time by Madeline L'Engle. In the story the students will read about the adventures of Meg and Charles Wallace.

a. Discuss traveling through space and living on a different planet.

b. Have the students in a group or individually list the plants and places visited in the story.

c. Students can then either individually or as a group relay the events to the class.

d. Split the class into groups and assign each group a place visited by the book. Each group will draw a picture of their location and create a travel brochure.

Reading Activity 2:

Activities can be altered to accommodate grade level.

Have the students or a group of students read Transall Saga by Gary Paulson. In the story the students will read about the adventures of Mark and his adventures when he ends up in an alien land.

a. Discuss traveling through space and living on a different planet.

b. Have the students in a group or individually list the plants and places visited in the story.

c. Students can then either individually or as a group relay the events to the class.

Reading Activity 3:
Activities can be altered to accommodate grade level.

Split the students into groups and have each group read either A Wrinkle in Time by Madeline L'Engle or Transall Saga by Gary Paulson.

1. In each group have the students list the places visited by the main character.
2. Have the students create a timeline of the major events in story and illustrate them.
3. As a class compare and contrast the two stories.

Reading Activity 4:
Activities can be altered to accommodate grade level.

After the students have read either A Wrinkle in Time by Madeline L'Engle or Transall Saga by Gary Paulson break the students into groups of 3 to create a play.

1. In each of the groups, have the students create a storyline (outline) for their script. The topics can be:
   - An interview with a main character on their travels
   - A continuation of what happens next in the story
   - A scene from the book
2. Write a script
3. Perform the play in front of the class

Book Report Activity 1:
Activity complexity can be altered to accommodate grade level.

This activity is designed to follow or replace the above lesson. After reading A Wrinkle in Time by Madeline L'Engle or Transall Saga by Gary Paulson students are to engage in the following activity.

1. Write a one page summary of the story.
2. Illustrate an event from the story.
3. In front of the class discuss the book and summarize the events of the story.

IV. Science

Activity complexity can be altered to accommodate grade level.
This lesson can be found at: http://school.discovery.com/lessonplans/programs/classroomplanetarium/

Planets Lesson:

MATERIALS:

- Round balloons in different sizes
- Tempera paint and paint brushes
- Fishing line
- Construction paper
- Newspaper torn into strips about one inch wide
- Space paste
- S-clips to suspend models from the ceiling tile frames or large paper clips

PROCEDURE:

1. Before you begin the activity, you will need to create a batch of "space paste." You can do this by mixing papier-mâché mix (or flour) and water to make a thick paste. Use about one part mix (or flour) to three-quarter part water

2. When the paste is ready, divide your students into nine groups. Assign each group a planet. Provide each student with a copy of the Planet Information Sheet which can be found at: http://school.discovery.com/lessonplans/worksheets/classroomplanetarium/worksheet1.html
Ask your students to fill in the chart using information they gather from library books and the Internet.

3. While they are working, turn a class bulletin board into a huge sun using construction paper. Invite any students who finish their research early to add solar flare designs to the sun.

4. Give each group a balloon. Explain to your students that all of the balloons should not be blown up to the same size. Stress that approximate size is all that is necessary, but that the big planets should be noticeably larger than the smaller ones—especially Pluto.

5. Provide each group with a long piece of fishing line. Ask them to tie the line around the end of their balloon.

6. Provide each group with a supply of space paste and newspaper strips. Instruct them to dip each strip into the paste, gently pull it through their fingers to wipe off extra clumps, and then paste it onto balloon. They should use many layers, working until the balloon is covered completely. Encourage them to apply extra layers to make their balloons seem as round as possible. (The planets aren't perfect spheres, so they don't need to worry too much about roundness.)

7. Allow the balloons to dry. While they are drying, students should decide how they are going to paint the surface of their balloons. Which colors will really bring out the physical landscape? When the balloons are ready—which might not be for a while—have students paint them.

8. While the painted planets are drying, meet with each group to determine where its planet should hang in relation to the sun image. You can use these approximations for distance from the sun: Mercury—58.9 million km, Venus—108.2 million km, Earth—149.6 million km, Mars—227.8 million km, Jupiter—778 million km, Saturn—1,427 million km, Uranus—2,870 million km, Neptune—4,500 million km, Pluto—5,900 million km. When the group has chosen a location, affix the dried planet model to the ceiling using the fishing line and the S-clips. Attach the appropriate Planet Information Sheet to each model.

Telescope Lesson Part 1:
Activity complexity can be altered to accommodate grade level. This activity was taken from http://www.howstuffworks.com/question568.htm

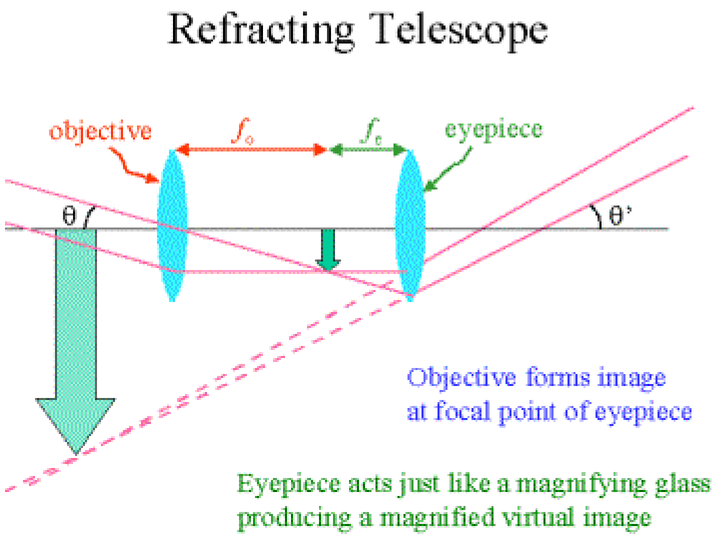
MATERIALS:
About 1 ½ feet of pipe insulation
Eyepiece magnifier (can be found at a dollar store)
Lens out of a pair of cheap reading glasses (also found at dollar store)
A picture of a telescope (provided)

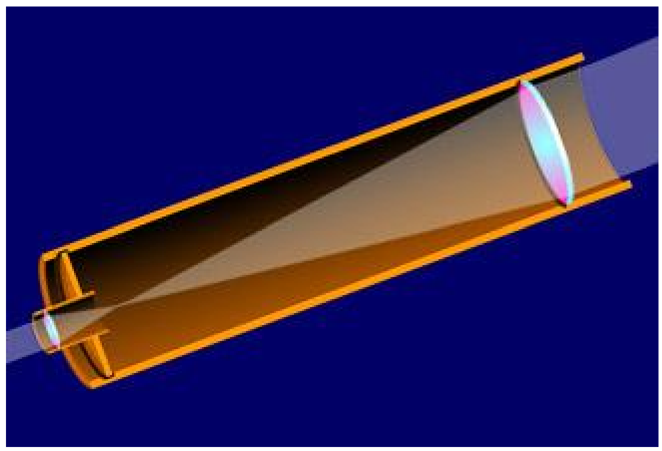
PROCEDURE:

1. After discussing parts of the telescope and the telescope handout break the students into groups.

2. For each group, supply students with their materials for building a telescope and let them put it together without any instruction.

3. Once students have put them together and had a chance to look at objects with it ask them why the image appears upside-down. Discuss solutions to this problem (inserting another lens or a mirror).





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Telescope Lesson Part 2:

Activity complexity can be altered to accommodate grade level. This activity was taken from http://www.howstuffworks.com/question568.htm

MATERIALS:
Two magnifying glasses - perhaps 1 - 1.5 inches (2.5-3 cm) diameter (it works best if one is larger than the other)
A cardboard tube - paper towel roll or gift-wrapping paper roll (it helps if it is long)
Duct tape
Scissors
A ruler, yard stick, or tape measure
Sheet of printed paper - newspaper or magazine will do

PROCEDURE:

1. Get the two magnifying glasses and a sheet of printed paper.

2. Hold one magnifying glass (the bigger one) between you and the paper. The image of the print will look blurry.

3. Place the second magnifying glass between your eye and the first magnifying glass.

4. Move the second glass forward or backward until the print comes into sharp focus. You will notice that the print appears larger and upside down.

5. Have a friend measure the distance between the two magnifying glasses and write the distance down.

6. Cut a slot in the cardboard tube near the front opening about an inch (2.5 cm) away. Do not cut all the way through the tube. The slot should be able to hold the large magnifying glass.

7. Cut a second slot in the tube the same distance from the first slot as your friend wrote down. This is where the second magnifying glass will go.

8. Place the two magnifying glasses in their slots (big one at front, little one at back) and tape them in with the duct tape

9. Leave about 0.5 - 1 inch (1 - 2 cm) of tube behind the small magnifying glass and cut off any excess tube remaining.

10. Check to see that it works by looking at the printed page. You may have to play slightly to get the exact distances between the two glasses right so that the image comes to a focus.

ACTIVITY 1 AND 2 CONCLUSION:

1. Have the students write a comparison of the two telescopes. Discuss the following before asking the students to complete the writing assignment.

What was different about the processes of both telescopes?
Which was more difficult to build?
Which was more difficult to see through?
Which telescope was more effective? Why?

Students can use both written descriptions as well as sketches to describe how a telescope works and the differences between the two.

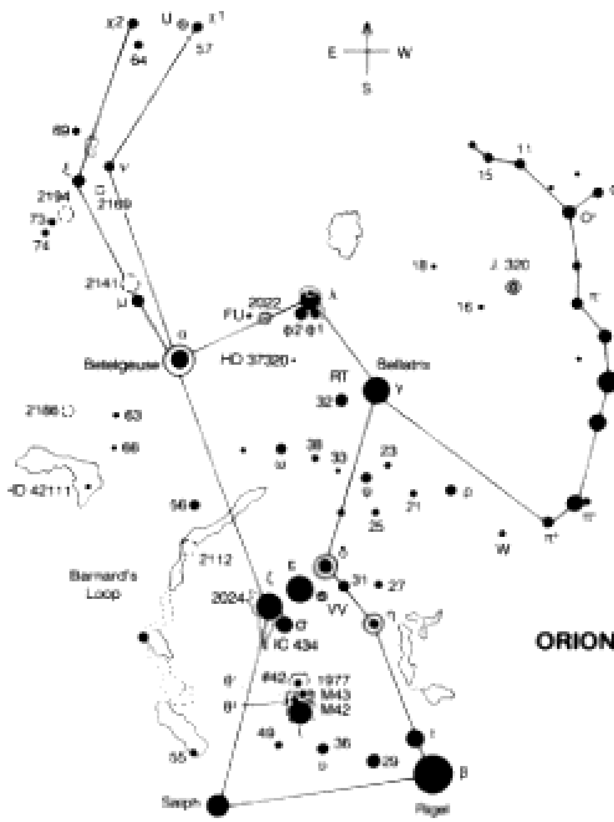
Telescope Lesson 3:
This activity was created to demonstrate the three basic types of telescopes. This lesson can be found at http://www.bro.lsu.edu/telescope/Classroom/2.How%20Telescopes%20Work/lesson.html

CONSTELATION LESSON:
The following lessons are designed to teach the basic concepts and facts about constellations. These lessons are filled with suggested activities to accommodate the different grade levels and learners in the classroom. A handout has been provided about constellations. More information can be found at: http://www.astro.wisc.edu/%7edolan/constellations/extra/constellations.html

What are Constellations?

So just what are these constellations you keep hearing about? You may go outside some night and see all kinds of stars, and maybe you have even spotted the Big Dipper (northern hemisphere) or the Southern Cross (southern hemisphere), but what about Leo the Lion or Pisces the Fish? What are they?

The first thing you need to know is that constellations are not real! The constellations are totally imaginary things that poets, farmers and astronomers have made up over the past 6,000 years (and probably even more!). The real purpose for the constellations is to help us tell which stars are which, nothing more. On a really dark night, you can see about 1000 to 1500 stars. Trying to tell which is which is hard. The constellations help by breaking up the sky into more manageable bits. They are used as **mnemonics**, or memory aids. For example, if you spot three bright stars in a row in the winter evening, you might realize, "Oh! That's part of Orion!" Suddenly, the rest of the constellation falls into place and you can declare: "There's Betelgeuse in Orion's left shoulder and Rigel is his foot." And once you recognize Orion, you can remember that Orion’s dog’s are always near by.



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This type of schematic draws the stars as different sizes to represent the difference in brightness. In addition, there is a standard way to connect the stars that allow astronomers and others who use charts like this to quickly tell what they are looking at. In almost every star atlas, you will see Orion drawn with these same lines.

You might also notice that every star on the chart is labeled (sorry that it came out a little blurry). This chart is useful because it accurately shows the relative positions of the stars in this small region of the sky. In addition, other things besides stars are also labeled on the chart. For example, Barnard's Loop on the left and M42 in the bottom middle are pointed out. Barnard's Loop is a cloud of faintly glowing gas, which can't be seen without a telescope. M42 is the Great Orion Nebula and it is the red splotch in Orion's Sword in the photo above. OK, so we know the constellations are helpful for remembering the stars, but why would people want to do that (besides astronomers, that is)? Why did they do that? Was it for some religious purpose?

Yes and no. Around the world, farmers know that for most crops, you plant in the spring and harvest in the fall. But in some regions, there is not much differentiation between the seasons. Since different constellations are visible at different times of the year, you can use them to tell what month it is. For example, Scorpius is only visible in the northern hemisphere's evening sky in the summer. Some historians suspect that many of the myths associated with the constellations were invented to help the farmers remember them. When they saw certain constellations, they would know it was time to begin the planting or the reaping.

This dependence on the sky became a strong part of many cultures. Perhaps there is something about the mystery of the night sky that makes people want to tell stories about the constellations. The picture at the left is an ornate star chart printed in 1835. Like the others, it shows the great hunter Orion. In this one, he is holding a lion's head instead of his traditional bow or shield. He has an eager look in his eye as he stalks Taurus, the Bull. Behind him, his faithful dog, Canis Major, is chasing Lepus, the Hare.

The constellations have changed over time. In our modern world, many of the constellations have been redefined so now every star in the sky is in exactly one constellation. In 1929, the International Astronomical Union (IAU) adopted official constellation boundaries that defined the 88 official constellations that exist today.

STAR CLOCK Lesson:

This lesson is designed to reinforce the movement of the constellations and how time was measured. This resource and lesson can be found at:
http://www.lawrencehallofscience.org/StarClock/starclockprintout.html

WHAT'S YOUR SIGN? LESSON:

This activity can be found at: http://www.col-ed.org/cur/sci/sci04.txt

OVERVIEW: People have always been interested in space and the fascinating and mysterious factors that surround it. Our society and our ever changing modern technological world are proving just how important our solar system is to our future.

Scientists are trying to find out what lies beyond the solar system. They are also interested in finding out how far space extends. With astronomy, there are so many areas to consider and much of our universe to study.

PURPOSE:
The purpose of this science classroom activity package is to provide space and solar system activities to aid in awareness of space education.

Students will learn the importance of our advancement in space technology and space education. The activities will demonstrate the science concepts in a more inviting and motivational manner.

OBJECTIVES:
Students will be able to:

1. Define astronomy as the science that involves space and all the bodies in it.
2. Identify the unit used to measure distances in space.
3. Infer that distances in the solar system are great and name the major use of the telescope.
4. Name three types of galaxies.
5. Identify the galaxy in which the solar system is located.
6. Distinguish the shapes of the three basic kinds of galaxies on a diagram.
7. Identify five common constellations, or star patterns.

ACTIVITIES:

1. Have the students use a dictionary to find words that begin with "astro." Help them interpret what the words mean.

2. Have the students measure the perimeter of the classroom in millimeters. Point out that using millimeters to measure the size of a room is somewhat like using kilometers to measure distances in space. (Both are too small to be useful)

TWENTY-FIRST Century Learning

3. Small groups of students can prepare models of the three kinds of galaxies. They may use Styrofoam pellets or tiny pieces of cotton glued to black poster board.

4. Draw a random arrangement of eight to ten dots on the chalkboard. Have the students imagine that these are stars in the sky and that they form some sort of picture. Call on a student to connect the dots with lines, thereby showing the object he/she is imagining. Have the students create a story about their imaginary objects.

5. While the stars seem to move in the sky, we don't see them move. They seem to move because the earth moves. This movement can be shown using a black umbrella and a star chart. Students may use chalk to draw a few familiar constellations on the underside of the opened umbrella. Be sure they draw the North Star at the point where the handle connects with the ribs of the umbrella. Slowly turn the handle of the umbrella counter-clockwise. This shows how the stars seem to move in the sky as the earth turns.

SPACE MILESTONES LESSON:

This lesson can be found at: http://school.discovery.com/lessonplans/programs/spacemilestones/

OBJECTIVES:

- Learn about major events in the history of the National Aeronautics & Space Administration (NASA).
- Create a visual timeline of the goals, heroes, and outcomes of select missions.

MATERIALS:

- Newsprint
- Paper and markers (for each group)
- Print resources about NASA's history and its various programs, from Mercury to the International Space Station

PROCEDURE:

1. Ask students to brainstorm names of astronauts from NASA space missions. For each astronaut, ask students if they know why his or her flight was significant.

2. It might be helpful to give students some background on the Cold War before continuing the lesson. Explain that the Cold War was not actually a war but a pervasive tension that existed between the United States and the Soviet Union for several decades following World War II. The primary source of conflict and tension between the two countries was rooted in the United States' distrust of communism, the Soviet form of government. When communism ended in the Soviet Union, the Cold War ended, as well. Ultimately, the Soviet Union itself dissolved, leaving independent nations, the largest of which is Russia.

3. Explain to students that NASA was founded in 1958, one year after the Soviets launched Sputnik 1, the world's first artificial satellite. During this period, the U.S. and the former Soviet Union had been engaged in the Cold War, so Americans saw Soviet advances in this "space race" as a dangerous technological gap between the two nations. Throughout its

history, NASA has made many achievements in aeronautics, space science, and space applications, but perhaps it is best known for its history of human spaceflights. Since NASA's inception, there have been seven major manned space programs, each with its own unique set of missions.

U.S. Manned Space Programs

Mercury: the first U.S. program for human spaceflight
Gemini: the first two-man crews, longer missions
Apollo: the first spaceflights to the moon
Skylab: a place where humans lived and worked in space for extended periods of time
Apollo-Soyuz: first international manned spaceflight
Space shuttle: the first reusable spacecrafts
International Space Station: an effort to create a permanent orbiting laboratory in space

4. Divide students into seven groups, and assign each group one of the manned space programs above. Have each group use the Web sites below to write a paragraph to answer each of the following questions about their assigned program:

What were the program's main objectives?
What years did the program run?
What type of vehicle was used for this program?

5. Have the students' record basic facts about one or two of the most significant missions of the program. Using one index card for each mission, record the following facts: name, dates, goals, heroes, and outcomes. Encourage students to print out or sketch images of spacecraft, astronauts, and any other pictures from each mission.
Students will find information for each program and its mission at the following Web sites:

http://www.hq.nasa.gov/office/pao/History/humansp.html
http://www.spaceflight.nasa.gov/history/
http://spaceflight.nasa.gov/gallery/index.html

For details about specific missions, see the following:

http://nssdc.gsfc.nasa.gov/planetary/chrono_astronaut.html
http://www-pao.ksc.nasa.gov/kscpao/factoids/hundred.htm

6. When groups present their reports to the class, encourage all students to present a different part. For example, one or two students in the group should give an overview of the program, other students' present information on the individual flights, and others present and describe the images from the missions.

7. Create a timeline on a bulletin board that spans the years from 1961 to the present. Have students hang their one-paragraph overviews for each program above the timeline in the appropriate periods. Then, at specific years of the timeline, have students post their index cards and images about individual missions.

8. End the lesson with a class discussion about how human spaceflight has evolved over the past 40 years. Which events do they believe were the most important achievements in the space program? What were some of the major challenges? How do they envision the next 40 years of human spaceflight?

GALILEO'S DIALOGUE LESSON:
This lesson can be found at: http://school.discovery.com/lessonplans/programs/greatbooks-galileosdialogue/

OBJECTIVES:

- Students will understand how Galileo's conclusions about the position of Earth in the solar system raised objections from the church.
- Students will understand that Galileo lived at the beginning of a period in which scientific inquiry flourished.

MATERIALS:
- Recent magazine and newspaper articles on controversial advances in science
- Audiotapes and videotapes of radio and television discussions about controversial scientific topics

ACTIVITIES:
1. Help students to appreciate the heightened emotions that scientists, on the one hand, and the Church, on the other hand, felt when Galileo published his theory about Earth's position. That is, bring home the conflict between science and tradition today. Elicit from students scientific breakthroughs that humans are experiencing or may shortly be experiencing—breakthroughs that some members of society think should not be carried out. Students should come up with some of the following controversial issues:

Cloning of animals
Cloning of humans
Genetic reengineering, genetic screening
Fertility treatments
Further research into space
Radiation of food
Greatly extending the average life span

2. Break students into groups, and have each research one of the preceding issues or other similarly controversial ones. The research should expose students to both sides of the issue—arguments for proceeding with scientific inquiry or breakthroughs as well as arguments for not proceeding.

3. Once the research is complete, assign half of each group's members the role of scientists working in the field, asking for support for their work to continue. Assign the other half of the group to play the roles of skeptical government officials, media, and concerned citizens, all of whom think it is improper to continue this line of scientific research and development. Have the students face each other in a news conference called by the scientists, who have an announcement to make. The government officials, media, and concerned citizens should ask challenging questions of the scientists and make statements of their own. Assign one student

from outside the group to act as moderator for the news conference, introducing the scientists and calling on the government officials, media, and citizens who have questions or comments.

4. The rest of the class, watching each news conference, should comment on which side has stronger arguments or makes a better case—the scientists or the challengers of the scientists.

5. Sum up the project by making sure students understand that strong arguments exist on both sides of each issue, that seldom does one side have all the answers.

DISCUSSION:

- Explain the significance of Galileo's observations of Jupiter and its moons, and evaluate Galileo's contributions to science and history.
- Discuss how the Copernican system threatened Church doctrine, and why the Dialogue of Galileo—a devout Catholic—offended the Church.
- Debate Galileo's decision to recant his heliocentric views. Do you consider this cowardice, or did Galileo have no choice? What would you have done in his situation?
- Discuss why students of world history need to study Galileo, the Catholic Church and its Inquisition in order to understand the Scientific Revolution, the Protestant Reformation, and the subsequent Enlightenment (Age of Reason).

UNDERSTANDING SPACE LESSON:

This lesson can be found at: http://school.discovery.com/lessonplans/programs/understanding-spacetravel/

At some time in the future, there likely will be cities in space. The first of these cities will probably be lunar based, Mars based, or space based (orbiting Earth). Designers of such a city will have to work within the parameters of the unique conditions of the base environment. Designers will have to consider the conditions and services that will be necessary for people living in the city.

MATERIALS:

- Computer with Internet access
- Research materials on the moon, Mars, and space stations

PROCEDURES:

1. Discuss with your class the design of a large city near your area. What materials are common in buildings and other structures? What kinds of recreation facilities are available? How is power provided to the residents? What are the main businesses and industries carried out in the city? Can students think of any reasons for the characteristics they have ascribed to the city? Are the city's characteristics related to its geography, location, or available natural resources? In what ways

2. Continue the discussion by pointing out that, in the future, we are likely to have cities in space—either lunar based, Mars based, or space based (i.e., orbiting Earth). Go on to point out that, as on Earth, the characteristics of space cities will be, in part, dictated by the unique conditions of the base environment.

3. Divide the class into three teams. Team 1 will design a lunar-based city; Team 2, a Mars-based city; and Team 3, a space-based city.

4. Before beginning, Teams 1 and 2 should research the base environments of the moon and Mars; Team 3 should research space stations.

5. Set aside a time for the three teams to meet and plan their cities with the following questions in mind:

What building materials will be available?
Which jobs will be required; what skills will people need?
What kind of recreational facilities should be available for the inhabitants?
How will power, food, water, oxygen—the necessities—be provided?
What conditions and services will people need?
Are there any special scientific research projects that could be carried out on this base that are unique to this location?
What types of businesses and commercial services will be most likely to thrive in this city?

Team members should share the task of preparing written answers to each of the preceding questions.

Have teams create computer-aided designs, physical models, or drawings of their cities and present them to the class.

Following the presentations, students can prepare written reports on one of the following:

Life at the Base ("A Day in the Life of a . . . Student, Scientist, Teacher, Doctor, Artist, Writer, etc.")

Tourist Brochure (tourist traps; best restaurants; sports activities; museums; historic sites, such as Apollo and other landing sites on the moon, Viking and Pathfinder on Mars).

The Daily News (newspaper that communicates the current events on the base)

VI. Writing

MATERIALS:

- Prompt (student masters of prompt are provided)
- Paper
- Pencils

PROMPT:
You and your class have spent the day hiking near the top of Mauna Kea. It's getting late and you and your class have begun the journey back to the bus. During your hike you decide to sneak away and sleep here on Mauna Kea. When you realize that you can no longer see the rest of your class you begin your journey to your camp spot for the night. You are excited and looking forward to your view of the stars from this point. But there are a few things you did not consider. You forgot about what your teacher had taught you about Mauna Kea. Are you prepared for all that you will see, feel and experience? What about the temperature? What about the spirits who rest on this mountain? Will they let you stay? Finish the story, what happens now?

PROMPT:
Mark Twain called Waimea canyon "the Grand Canyon of the Pacific." Think about Mark Twain and his visit to Waimea Canyon years ago. What other famous writer or Astronomer might have enjoyed seeing Mauna Kea? If Galileo could have visited Mauna Kea, what might he have said? What would he have done? If he could be here today and look at the new telescopes that have been built to see the stars, what do you think his reaction might be?

PROMPT:
You are working at the Keck telescope in Mauna Kea. You have been asked to work one night for another employee who is sick. Tonight you are to fill in for him by staying up all night to watch a particular star formation. It's late and you are getting really tired. When all of a sudden you see something you have never seen before…. A NEW PLANET! You rub your eyes but no- It's really there!! You call your supervisor who rushes down to see this new planet. "You are going to be famous," he says. What happens now over the next week is up to you. Do you write a book and turn it into a movie? Do you give some of the credit to the guy who stayed home sick? Do you become rich and famous? What happens now?

PROMPT:
You and your best friend are outside watching the meteor shower and making wishes on all the meteors you see. "I wish to get an A on my math test," your friend says out loud.
"I wish that an alien would land on earth and move in with me so he could do all my chores!" you answer back.
At that moment a meteor flies across the sky and looks as if it would hit you both! Before you could speak a voice says "Your wish is granted!"
Both of you jump up, startled and not sure what you will see when you turn around.
When you did finally look, standing there in front of you is a…. Finish the story. Make sure that the story has a conflict and resolution.

TWENTY-FIRST Century Learning

1. Copy the prompt to an overhead transparency or copy the prompt for each student.

2. Have each student write a story that completes the prompt. The can vary in length depending on grade level appropriateness.

Further Investigation: ideas to enhance students' learning *after* the excursion
Reflection
RAFT Assignments: **R**ole, **A**udience, **F**ormat, **T**opic
RAFT assignments offer creative ways to engage students in reflective thinking and to build students' writing skills. Students take a specific 'role', write with a particular 'audience' in mind, following a certain format on an assigned topic. The following are examples that relate to the journey:

5-8 *(RAFT could be completed as a class activity)*
Role: An astronomer at Mauna Kea
Audience: Students
Format: Magazine article
Topic: Studying the stars without looking at the night sky

Workbook/Activity Resources:
1. Magic School Bus – fun pictures with great scientific captions and facts on a variety of science topics.

2. This is a resource that looks at the space discoveries of Galileo.
http://www.hps.cam.ac.uk/starry/galsidnun.html

3. This resource assists in designing assessments on the solar system.
http://www.edhelper.com/SolarSystem_Grades1to3_90.htm

4. This resource is filled with activities to further the understanding of the solar system.
http://www.edhelper.com/SolarSystem.htm

5. This resource is filled with activities to further the understanding of Astronomy.
http://www.atozteacherstuff.com/go/search.cgi?grade=3-5&catid=114&t=themes

6. "How to Build a Telescope." This is a resource that describes the process of building a model of the first telescope.
http://www.funsci.com/fun3_en/tele/tele.htm#1

7. This is a resource that is an interactive site for students to use to learn more about Astronomy.
http://www.dustbunny.com/afk/

8. This is a resource that will help further the study of stars and constellations.
http://www.astro.wisc.edu/%7edolan/constellations/constellations.html

Additional Resources
The resources provided offer background information and ideas for integrating the excursion within a larger context of study.

1. Mrs. Jeepers in Outer Space, by Debbie Dadey. This is a book that can be used to further the imagination of students as they learn more about astronomy.

2. How I Learned to Fly, by R. L. Stine. This is a book that can be used to further the imagination of students as they learn more about astronomy.

3. Cam Jansen and the Mystery of the U.F.O., by David Adler. This is a book that can be used to further the imagination of students as they learn more about astronomy.

4. My Life Among the Aliens, by Gail Gauther. This is a book that can be used to further the imagination of students as they learn more about astronomy.

5. The Door in the Lake, by Nancy Butts. This is a book that can be used to further the imagination of students as they learn more about astronomy.

6. New World, by Gillian Cross. This is a book that can be used to further the imagination of students as they learn more about astronomy.

7. The Winds of Mars, by H. M. Hoover. This is a book that can be used to further the imagination of students as they learn more about astronomy.

8. Young Star Travellers, by Isaac Asimov, Martin Greenberg, & Charles G. Waugh This is a book that can be used to further the imagination of students as they learn more about astronomy.

9. *Ariel tour of Mauna Kea.* This is a resource that gives more information and pictures of the observatories found at Mauna Kea.
http://www.ifa.hawaii.edu/images/aerial-tour/

10. *Mauna Kea Observatory.* This resource can be used for further information on Mauna Kea and specific details about the different telescopes on Mauna Kea.
http://en.wikipedia.org/wiki/Mauna_Kea_Observatory