Building A Telescope

Objective:	To construct a simple refracting telescope.

Grade Level: 5-8
Subject(s): Physical Science, Space Science, Technology
Prep Time: 30 minutes
Duration: 50 minutes
Materials Category: Special

National Education Standards	
Science	6a, 6b
Mathematics	
Technology (ISTE)	
Technology (ITEA)	3c, 3d, 6a, 6b
Geography	

Materials:

- Two converging lenses (convex lenses)
- Telescoping tubes (mailing tubes)
- Manila file folder
- Scissors
- Knife
- Glue
- One white poster board
- Red and black tape or construction paper

Related Links:

Lesson adapted from:
Optics—Light, Color, and Their Uses
http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Optics/Optics.Guide.pdf

Space-Based Astronomy
http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Space.Based.Astronomy/Space.Based.Astronomy.pdf

Supporting NASAexplores Article(s):

The Shuttle-Hubble Connection
http://www.nasaexplores.com/show2_articlea.php?id=02-012

Building A Telescope

Teacher Sheets

Pre-lesson Instructions

1. Lenses and mirrors can be obtained at little or no cost through creative scrounging. Try the following places:
    - Ask an optometrist or eyewear store for damaged eyeglasses. The lenses are suitable for classroom experiments.
    - Check out rummage sales and flea markets for binoculars and old camera lenses.
    - Lenses and mirrors can also be purchased from science supply catalogs.
2. Bifocal and trifocals make fascinating magnifying lenses.

Background

In April 1990, the crew of the Space Shuttle Discovery launched the Hubble Space Telescope. This telescope combines ultraviolet and optical imaging with spectroscopy to provide high quality data of a variety of astronomical objects. Although the primary mirror aboard the satellite was later discovered to be slightly flawed, astronomers were able to partially compensate for the slightly out-of-focus images through computer processing. In December 1993, the Hubble servicing mission permitted astronauts to add compensating devices to the flawed mirror, to readjust its focus, and to replace or repair other instruments and solar arrays. The servicing mission has led to images of unprecedented light sensitivity and clarity.

Guidelines

1. Distribute the Student Sheets and materials.
2. Go over instructions with students, and provide guidance.

Discussion / Wrap-up

- The student will observe with and without the telescope. After observing the stripe chart, the student will make a judgement about the amount the telescope magnifies. Generally, simple telescopes constructed by students will have a magnification of less than five.
- This is a refracting telescope, and the image will appear upside down.
- The useful magnification of a telescope is limited by diffraction. This diffraction limit is about 10 times magnification per inch of diameter of the objective lens. For example, an objective lens 2 inches in diameter will provide a realistic telescope power of 20 times.

Extension(s)

- Bring commercially made telescopes, spyglasses, and binoculars into the classroom. Compare magnification, resolution, and light-gathering power to the telescope the students made.
- Invite a local astronomer to talk with the class.

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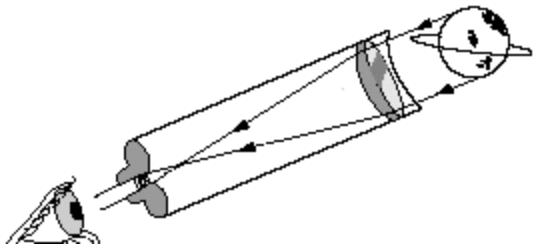
Student Sheet(s)

Background

A telescope is used to observe objects in the sky. A telescope makes faint small objects appear brighter and larger. In a telescope, the lens held next to your eye is called the eyepiece and is usually short focal-length lens or a combination of lenses. The lens at the other end of the telescope is called the objective lens. Light from a distant object is focused by the objective lens to form an image in front of the eyepiece. The eyepiece acts as a magnifier and enlarges that image. The magnification of the telescope can be found by dividing the focal length of the objective by the focal length of the eyepiece.



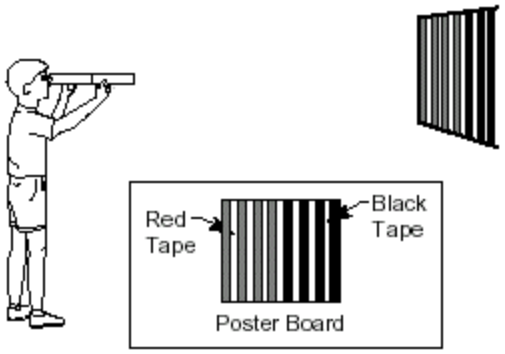
Materials

- Two converging lenses (convex lenses)
- Telescoping tubes (mailing tubes)
- Manila file folder
- Scissors
- Knife
- Glue
- One white poster board
- Red and black tape or construction paper

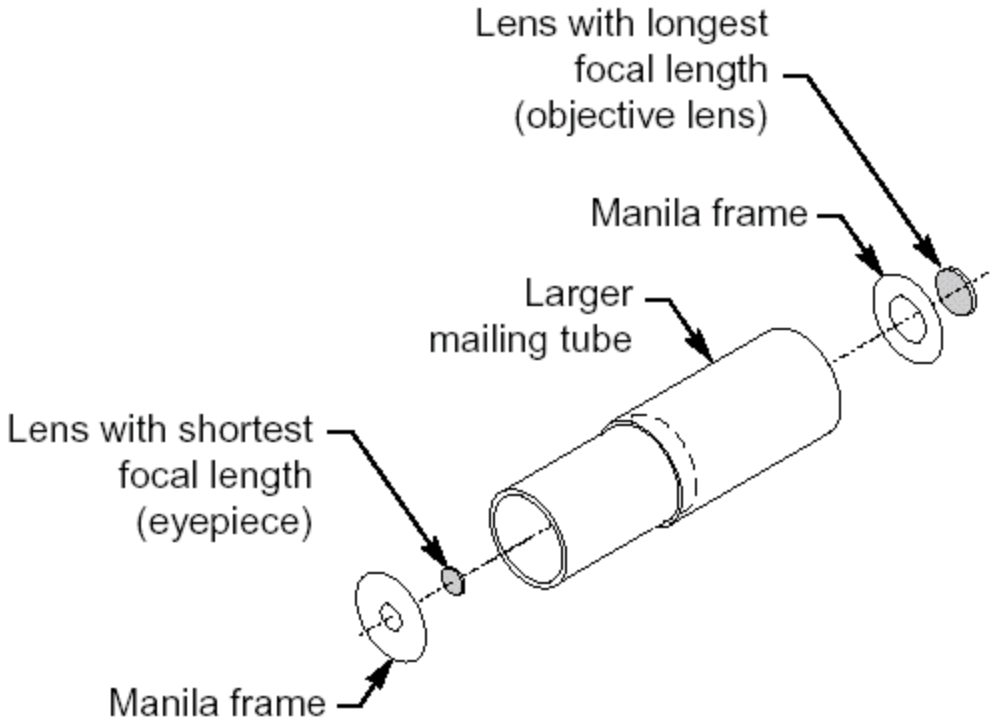
Procedure

1. As you are constructing your telescope, use the diagram on the next page. The mailing tubes will be the body of the telescope with the smaller one sliding inside the larger one. The length of the assembled telescope will be a little longer than the sum of the focal lengths of the two lenses. Add the value of the focal lengths of the short and long lenses together. Divide that length by two, and then add another inch. Cut both of the tubes to that length with a knife.

2. Use the scissors to cut out two circles from the manila paper that are the same size as the diameter of the mailing tube. These circle frames will mount and center the lenses on the tube. With a knife, cut out circles that are slightly smaller than the diameter of the lenses in the center of the paper frame circle. Glue the lenses to the center of the frame. The shorter focal-length lens will be the eyepiece. Glue that framed lens to the end of the smaller tube. Glue the other framed lens to the end of the larger tube.
3. Slide the two cardboard tubes together. You have now assembled a simple refracting telescope. Look through the eyepiece of your telescope, and focus it on a distant object. Slide the two cardboard tubes in and out until you have a clear image. What do you observe?
4. Use the red and black tape to make stripes on the white poster board to use as a chart. Stand at one end of the room, and look at the chart with the red and white stripes, and black and white stripes. Looking directly at the chart with one eye, look through the telescope with the other eye. This may be a little difficult at first, but with a little practice you will find that you can do it.



5. Describe how much is the chart magnified?
6. How was the observed image oriented?



Questions

1. Why do we need telescopes to study space?
2. Why do we have a telescope in space orbiting the Earth?