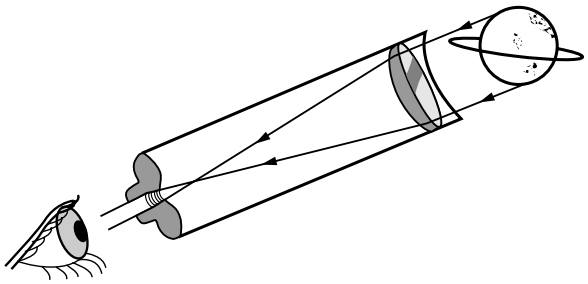
Building a Telescope

Objective

The student will construct a simple refracting telescope and calculate the magnification.



Science and Mathematics Standards

Science Standards

☑ Science as Inquiry
☑ Physical Science

Mathematics Standards

☐ Problem Solving
☑ Communication
☐ Connection
☑ Computation/Estimation
☐ Measurement

Theory

In a telescope, the lens held next to your eye is called the eyepiece and is usually a 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

- 2 converging lenses (convex lenses)
- telescoping tubes (mailing tubes)
- manila file folder
- scissors
- knife or saw
- glue
- 1 white poster board
- red and black tape

Procedures

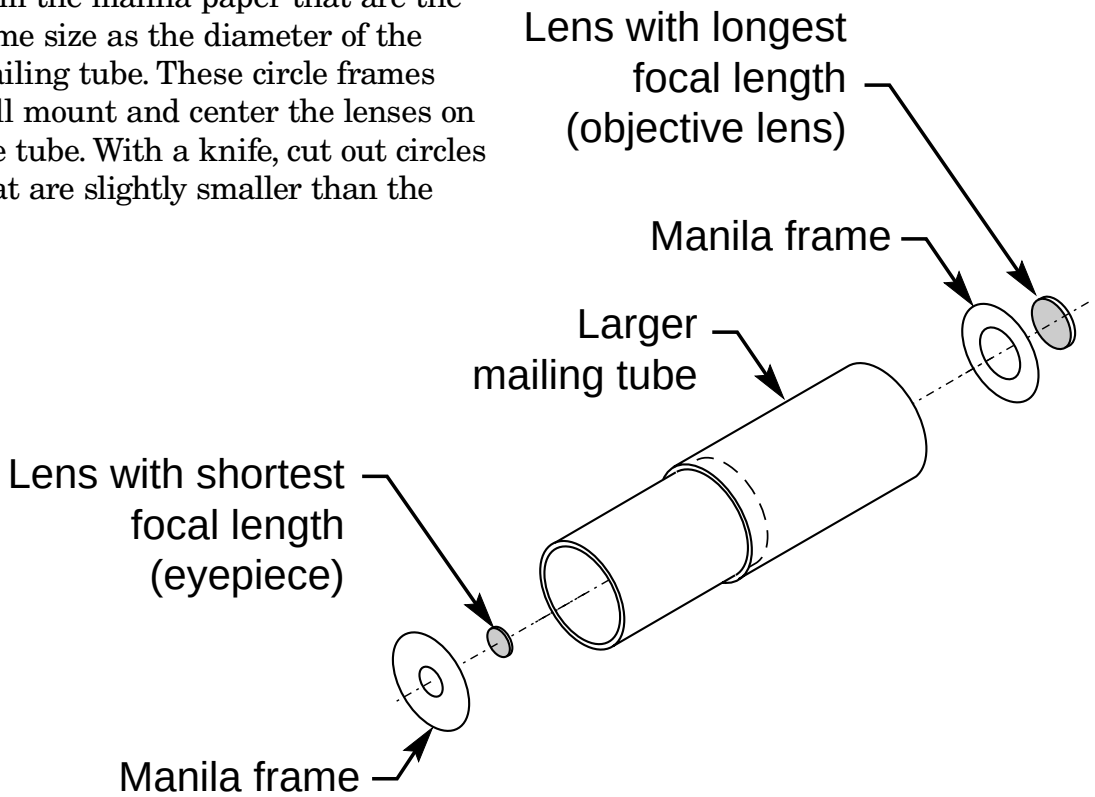
This telescope will be constructed using the same lenses that were used in the experiment named, "Focusing Light With a Lens," page 49.

1. 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 lens together. Divide that length by two and then add another inch. Cut both of the tubes to that length with a knife or saw.

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 posterboard (see illustration on page 55) to use as a chart.



Observations, Data, and Conclusions

1. To compute the power or magnification (**M**) of your telescope, you will use the focal lengths computed in the experiment named, "Focusing Light With a Lens," page 49. Insert the number for each previously computed focal length into the following equation:

   M = power or magnification

   $\mathbf{F_e}$ = focal length of the eyepiece

   $\mathbf{F_o}$ = focal length of the objective

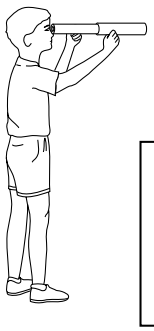
   $$\mathbf{M} = \frac{\mathbf{F_o}}{\mathbf{F_e}}$$

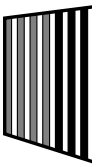
   The magnification of my telescope is

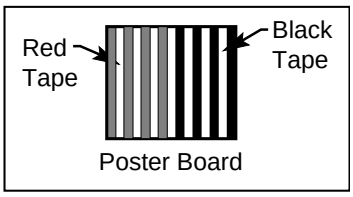
   _____

2. Evaluate your calculated magnification. Stand at one end of the room and look at the chart with red and white stripes, and black and white stripes. Look directly at the chart with one eye and 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.

3. How much is the chart magnified?







4. Do you think the amount of magnification observed through your telescope matched the magnification you computed for your telescope?

5. In observing objects through your telescope, did the image appear clear?

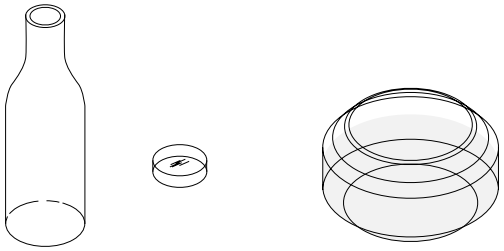
6. How was the observed image oriented?

Comment: 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.

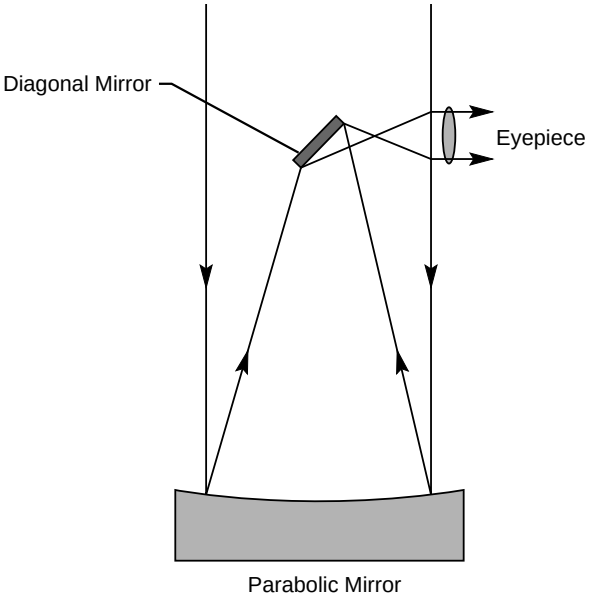
Example: an objective lens 2 inches in diameter will provide a realistic telescope power of 20 times.

Junior Home Scientist

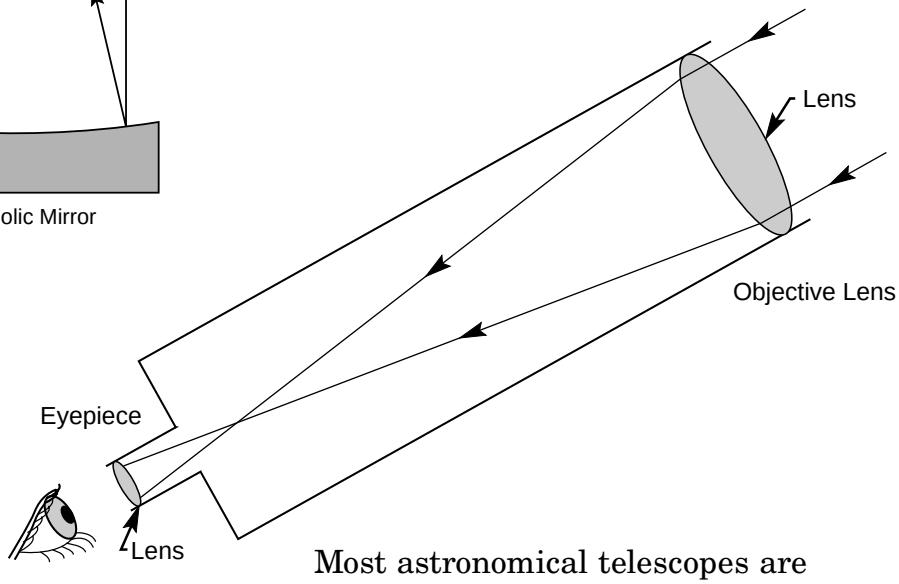
Converging lenses can be found in many of the everyday items we see in our homes. How many can you find? Here are a few examples: Paperweights, fish bowls with water in them, bottoms of soda bottles, etc.



Newtonian Reflector Telescope



Refractor Telescope



Most astronomical telescopes are reflectors. Objective mirrors are easier to make than objective lenses. Large mirrors are structurally easier to design and less expensive to build than large lenses.

Building a Telescope

Observations, Data, and Conclusions

Pages 55

1. Answers will vary with the lenses used.

2. The student will observe with and without the telescope. After observing the striped chart, or some other object provided, the student will make a judgment about the amount the telescope magnifies. Generally, simple telescopes constructed by students will have a magnification of less than five.

3. Answers will vary with the lenses used.

4–5. These questions were included to encourage the student to observe carefully.

6. This is a refracting telescope and the image will appear upside down. For more information, see telescopes in an encyclopedia.

Building a Microscope

Observations, Data, and Conclusions

Page 58

1–2. Answers will vary.

3. The microscope with the better set of lenses will have a clearer, sharper image.

4. The purchased microscope will be better.

5. The purchased microscope is better because the glass in the lenses is a better quality and has been ground and polished more carefully. It is also mounted and aligned more precisely.

Interference Fringes

Observations, Data, and Conclusions

Page 62

1. See the top left figure on page 62.

2. See the bottom left figure on page 62.