BUILDING A SIMPLE REFRACTING TELESCOPE

grades 5–8

Objective

To build a simple refracting telescope.

Introduction

A simple refracting telescope is very easy to create. All that is needed are two convex lenses and two cardboard tubes. The first part of this activity demonstrates the inner workings of a telescope, and the second part demonstrates how to construct a simple refracting telescope. The lenses that will be used in this telescope are very similar to the lenses used by Galileo Galilei in the 17th century.

Within a refracting telescope there are two lenses: an **objective lens** and an **eyepiece.** Part 1 of the activity demonstrates how light passes through the first lens and is bent (or refracted) to a focal point. Using a blank piece of paper, students can see where the focused image is formed. When another lens is placed on the opposite side of the piece of paper it acts like a magnifier, making the image appear larger. This arrangement of lenses demonstrates the simplicity of the basic telescope.

Part 2 of the activity demonstrates how to construct a telescope and use it to view distant objects. The same lenses used in part 1 can be used in part 2 with the cardboard tubes to hold the lenses in place. The tubes slide inside each other to focus the telescope. After observing the process of light refraction without a telescope tube, students should have a clear understanding of what happens when they point their simple telescope at a distant planet or object.

Background Reading for Educators

Telescopes: Super Views of Space, available at https://www.amnh.org/learn-teach/curriculum-collections/discovering-the-universe/telescopes-super-views-from-space

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Materials

Set of lenses
These can be ordered from Sergeant-Welch (1-800-727-4368) part # WL53200-38L A and B, $0.99/lens)

Note: These lenses can also be purchased in sets of 20. If you use your own lenses, try to ensure that one lens has at least twice the focal length of the other. The recommended lenses for this activity have focal lengths of 285 mm and 96 mm.

Styrofoam cups
40–75 Watt red bulb
Desk lamp or flashlight
Scissors
Blank piece of paper
Transparent tape
Set of cardboard tubes
(paper towel tubes are an ideal length)

Procedure

Preparing for the Activity

1] To prepare for the activity, mount each lens onto a stand made from an upside-down Styrofoam cup. The lens must be standing up vertically, so you can look through it from the side. You can attach the lens to the bottom of the upside-down cup with transparent tape. For extra stability, stick the lens into a slit in the cup and tape in place from inside.

2] If you have multiple sets of lenses, arrange the desks in the room so that teams of two or three students can work together. Place the lamp with a bare red bulb in the center of the classroom, and arrange the work areas around it so that each group is situated at least five feet from the lamp. Try to arrange the lamp so the bulb is level with all of the desks.

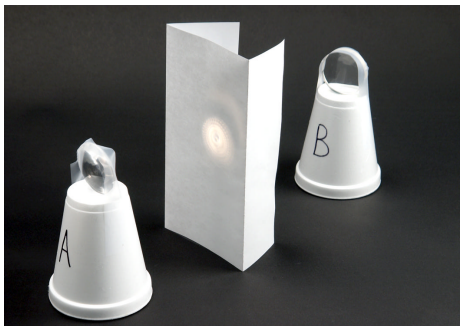
3] Prepare the sets of sliding tubes. If your tubes are the same size, they can be made into sliding tubes by slitting one of them lengthwise and sliding it over the other one.

Part One: A Telescopic View

4] Hold up two sample lenses.
Ask: What do telescopes use to focus light from distant stars and galaxies?
Explain: Astronomers can use two different kinds of optical pieces to focus light: mirrors and lenses. The lenses used in this activity are miniature versions of what astronomers use in their refracting telescopes.

5] Pass out a pair of lenses attached to Styrofoam cup stands to each group. Have your students examine the equipment and label the larger lens "A" and the smaller lens "B" by writing on the cups. Turn off all the lights in the classroom and turn on the red bulb. Students should place the Styrofoam cup with the large objective lens (cup A) on the side of their desk closest to the lamp. The red light and the Styrofoam cup need to be level, so you may have to adjust the lenses by placing books underneath the cups. It will be simpler for your students if you can start with the light at the correct level.

Meg Carlough/AMNH



Telescopic view.

6] Have one of the students in the group hold a piece of white paper behind cup A and move it to a position where the light from the lens appears focused and clear. An image of the red bulb should appear on the paper.
Explain: They have just found the focal point of the lens.

7] Place cup B on the other side of the paper, so the paper is between the two lenses, and have students observe the image of the light bulb on the back-side of the paper. Once again, this lens must be level with the other cup and the beam of light. Ensure that when your students look through the lens, their eyes are level with the other devices. Move the cup forward and backward until the image is clearest. Remove the white paper.
Explain: You now have a telescopic view of the light!

Part Two: A Simple Refracting Telescope

In this part you will first demonstrate to the class how to make a simple telescope and then let them construct one on their own.

8] Remove a set of lenses from their respective Styrofoam cups.
Explain: You are now going to construct a very simple refracting telescope.

9] Center the eyepiece lens (the small lens from cup B) on the end of the smaller of the two cardboard tubes. Carefully tape it to the end of tube. Tape the objective lens (the lens from cup A) to the end of the larger tube. Slide the smaller tube into the larger one. Place a rubber band around the two tubes to secure the system. The smaller tube should be able to slide in and out so you can focus a distant image.
Explain: You now have a simple telescope.

10] With a desk lamp or flashlight, illuminate a distant bright poster in one corner of the room. Stand on the far side of the room and view the poster through the telescope. Move the telescope tubes in and out until you have a clear, focused image.
Ask: Can you distinguish the colors?
Explain: This basic telescope may not produce a very clear image, but you will be able to clearly see colors on a distant poster. The first simple telescopes were really nothing more than crude "spyglasses" such as these.

11] Have the students follow these same directions and test their own telescopes by looking at the poster or at an object outside of the classroom window.