

## Replicating a Telescope

**Grade Level Targeted:** 5-8

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This activity can be extended to higher grades by not showing the students an example; can be used in lower grades by telling them step by step how to put the telescope together.

Design of telescope adapted from [www.ehow.com](http://www.ehow.com), How to Make a Simple Telescope, © 1999-2005 eHow, Inc. How things get done.

### **Educational Standards:**

National Science Standards: Content Standard A, Science as Inquiry: all students should develop abilities necessary to do scientific inquiry and understandings about scientific inquiry.

National Science Standards: Standard B, Physical Science: all students should develop an understanding of properties and changes of properties in matter, motions and forces and transfer of energy.

National Science Standards: Content Standard E, Science and Technology: all students should develop abilities of technological design and understandings about science and technology.

National Science Standards: Content Standard F, Science in Personal and Social Perspectives: all students should develop understanding of personal health, populations, resources and environments, natural hazards, risks and benefits, and science and technology in society.

National Science Standards: Content Standard G, History and Nature of Science: all students should develop an understanding of science as a human endeavor, nature of science, and history of science.

**Success Indicator:** Upon completion of the activity, students will have a better understanding of how light refraction and telescopes work.

**Engineering Connection:** Mechanical engineering is often figuring out how things work and making useful tools.

**Setting up the Activity (for facilitator):** For this activity, have students work in groups of three or four. Obtain enough materials for each group and a set to make an example.

### **Materials Needed Per Group:**

1 Large Convex Lens (A low powered magnifying glass works best. Magnifying glasses can be found at drugstores, school supply stores, and optical shops.)

1 Small Concave Lens (A high powered one will work best. Concave lenses can be found at optical shops; ask them for discarded ones.)

1 Large Gift Wrap Cardboard Tube

1 Small Gift Wrap Cardboard Tube

Styrofoam or Cardboard (Needed for gaskets. Gaskets are rings that fit tightly in the joint between two surfaces to form an airtight seal. In this case, it would be a piece of Styrofoam that fits tightly in the cardboard tube and would hold the lens in place. Gaskets will not be needed if lenses are fitted to the cardboard tube and can be held in place without them.)

Hot Glue Sticks (several)

2 or 3 Hot Glue Guns (Low Temperature): A facilitator should operate the glue gun to prevent burns and injuries.

Markers, metal scraps, aluminum foil (items to decorate)

### **Make The Galilean Telescope Example:**

1. With a set of materials, figure out how far apart the lenses should be. Look through the small concave lens while holding the larger, convex one out in front of you. When an object focuses in the distance, measure the length between the two lenses.
2. Double that measurement. This is the length your two cardboard tubes should be.
3. Hot glue the larger lens at the end of the wider tube.
4. At the end of the smaller tube, hot glue the smaller lens (your eyepiece). If the lens is much smaller than the tube, you will have to make a gasket (a ring) out of styrofoam or cardboard to hold the lens in place in the center of the tube.
5. The lenses should be parallel with each other and centered in each tube.
6. Place the smaller tube inside the larger tube and adjust to the measured length in step two.
7. Decorate to make it look more like a Galilean telescope (see picture at the end of this lesson).

**Introduction (for youth):** How do telescopes work? Have you ever wondered? Galilei Galileo was an Italian Scientist who wanted to see the stars and moon closer. He used light refraction from convex and concave lenses to develop the first optical telescope. What is light refraction? Light waves normally travel in parallel lines. If an object is in the way, the light waves will bend. Think about a time you've seen a penny in a fountain or pond. You may have reached down for the penny above water and missed it. That is because the light waves were bent, and the penny you saw was actually above or below where you saw it (depending on your position). Telescopes use a combination of convex and concave lenses to bend light so that you can see objects from far away up close. A convex lens is a magnifying glass and is thicker in the middle than the edges. A concave lens is often used in eye glasses. It is thicker on the edges and thinner in the middle. How did Galileo use these lenses? How does the light travel through them to allow us to see distant objects? Can you make a telescope like Galileo?

### **What to do:**

1. Work in groups of three or four. Get a set of materials either at a materials table or from your facilitator. The set includes: 1 large convex lens or magnifying lens, 1 small concave lens, 1 small cardboard tube, 1 large cardboard tube. Styrofoam and cardboard may be used as needed to help lenses fit in tubes correctly. Get decorative materials later.
2. Check out the example then look through your own lenses. Decide which one will be your eyepiece. Decide how far apart the lenses should be to focus on an object clearly. Notice on the example you may need styrofoam or cardboard to hold the smaller lens in place.
3. Glue lenses in to the cardboard tubes. Ask a facilitator for help on this one. Do NOT glue tubes together or you will not be able to adjust and focus!
4. Place smaller tube inside of the larger tube and adjust until you can focus on an object.
5. Get materials to decorate and make it look like a real Galilean telescope.
6. Clean up!

**Finishing it up (for facilitator):** *After all students have completed their telescopes, allow them to look through each other's at different objects. Lead a discussion to compare telescopes. Which ones worked? Which ones did not? How are they the same? How are they different?*

#### **a. Share What You Did:**

**How did you build your telescope?** *(Answers vary. Facilitator should share first step of how they made the example.)*

#### **What was the most difficult part of building your telescope and how did you solve it?**

*(Possible response would be deciding how far apart the lenses should be. Another response could be lining up the lenses so that they were parallel and in the center of the tubes. Facilitator should share the rest of the steps they used to make the example.)*

**What would your advice be for others trying to build a telescope?** *(Answers vary.)*

#### **b. Process What's Important:**

**What are the differences between convex and concave lenses?** *(Convex lenses magnify light. They are thicker in the middle and thinner on the edges. The light converges to one point. Concave lenses are thicker at the edges and thinner in the middle. They diverge light.)*

**Why do we use both types of lenses?** *(The lenses work together because the convex lens magnifies the object so we can see distant objects. The concave lens diverges the light so we can see what passed through the convex lens clearly and in greater detail.)*

**What is significant about the distance between the two lenses?** *(The distance allows the light to bend but still be focused so we can see the object clearly.)*

**How does the telescope work?** *(Light passes through the convex lens and converges at one point. Then light waves travel in parallel lines to the concave lens, which diverges the light to your eye.)*

**Generalize to Your Life:**

**How might life be different had Galileo never created the telescope?** (Possible answers might be that we would still think the Earth was the center of the universe, we would not know characteristics of planets or stars, etc.)

**What discoveries have been made through telescopes?** (Answers vary. Planets, stars, galaxies, asteroids, satellites/comets have all been discovered using telescopes.)

**Many of us use convex or concave lenses everyday, how?** (Eyeglasses usually use both types of lenses. Concave and convex lenses are in cameras and camcorders, microscopes, movie projectors, overhead projectors, etc.)

**Apply What You Learned:**

**What other tools do we use that contain a convex/concave lens?** (See previous answers.)

**What occupations are there in which optics are important?** (Astrologist, optometrists or eye doctors, scientists of all kinds use microscopes, photographers, camera person, etc.)

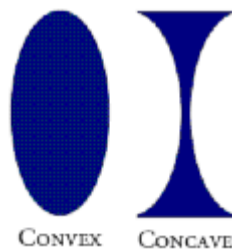
**How will you use your telescope in the future?** (Answers vary.)

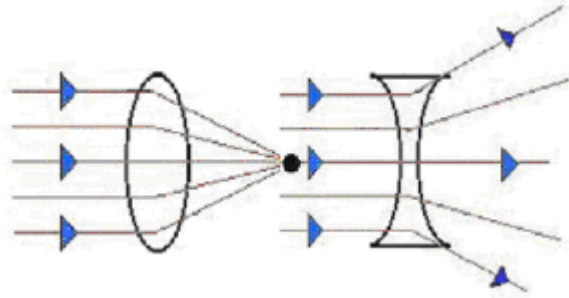
**More Challenges:**

*To help youth extend their understanding of light refraction and telescopes, they can look at the moon's surface through their telescope. Students can also compare the telescope they made with other types of modern day telescopes, like the Hubble Space telescope, by researching different types of telescopes and their developments through time.*

**Background Information (for facilitator):**

Galileo Galilei was an Italian scientist that invented the first optical telescope in the early 1600s. How it works: Light travels in parallel rays unless it is refracted by another object. Refraction, or the bending of light waves, is what happens when light hits a lens. When this light passes through a convex lens, it converges to a focal point. A convex lens is thicker in the center than on the edges. The light then travels in it's converged state to a concave lens. The concave lens, diverges light and is thicker on the edges than in the center. This is what magnifies the object so that we can see it. Pictures from <http://education.sdsc.edu/SE/opticsintro.html>.





Convex Light Travel

Concave Light Travel



Replica of Galilean Telescope

**Resources:**

[www.allwords.com/query.php?](http://www.allwords.com/query.php?)

<http://education.sdsc.edu/SE/opticsintro.html>

[www.ehow.com/how\\_17057\\_make-simple-telescope.html](http://www.ehow.com/how_17057_make-simple-telescope.html)

[http://galileo.rice.edu/lib/student\\_work/astronomy96/mtelescope.html](http://galileo.rice.edu/lib/student_work/astronomy96/mtelescope.html)

<http://images-www.kettering.edu/liberalStudies/images/galileanTelescope.jpg>



