

## **Chapter 5: Galileo's Refractor**

### Student Worksheet

#### **Objective:**

Create and measure magnification with lenses.

#### **Engage:**

The first telescope was not invented to look at the sky. Can you think of some useful ways a telescope could be employed in the early 1600s?

#### **Introduction:**

Contrary to popular belief, Galileo did not invent the telescope. Historians credit the Dutch inventor Hans Lippershey with that distinction. Galileo's innovation was to turn his telescope to the night sky, and to do so as a scientist. He made observations night after night in the search for truth. Galileo also made great improvements on the magnifying power of the telescope. In this activity you will learn about the focal length of a lens, and how lenses can be used together in the form of a most basic telescope.

#### **Procedure:**

##### **Part 1: Measuring focal length**

1. Examine the two lenses. Be careful to hold the lenses on their edges to avoid getting fingerprints on the glass. Notice how the lenses magnify and focus.
2. Make a simple lens holder by cutting a slit in the bottom of a foam cup. See a demonstration from your instructor.
3. Insert one of the lenses into the cup holder. Hold the lens in place with tape as shown by your instructor. Cut a slit in the bottom of another foam cup. Insert the screen into this slit.

4. Place the screen holder on the table. Move the lens closer to and farther away from the screen until you see an image of the colored lamp on your screen. Move the lens in small increments until you see a well-focused image.
5. Measure the distance in *cm* from the lens to the screen.
6. Fill in the table below, and repeat the procedure in question 3 above for the other lens.

|                   | Right-side up/<br>Up-side down | Magnified/<br>Smaller | Focal length<br>measured | Focal length<br>given by<br>instructor |
|-------------------|--------------------------------|-----------------------|--------------------------|--|
| <b>Thick lens</b> |                                |                       |                          |  |
| <b>Thin lens</b>  |                                |                       |                          |  |

5. Describe the differences between the shape of the long focal length lens and the short focal length lens.
6. Based on your observations, what can you conclude about the relationship between the focal length of a lens and the shape of a lens?

### **Part 2: A Two-Lens Telescope**

1. Hold the two lenses by the cups so that the thin lens is in front of the thick lens (in other words, so the thin lens is closer to you). Look at a distant object through the lenses. Move the lenses closer together and farther apart. Can you create a focused, magnified image? Describe what you see.
2. Now reverse the lenses, holding them so that the thick lens is closer to you. Again look at the distant object through the lenses. Move the lenses closer together and farther apart. Can you create a focused, magnified image of the distant object?



7. With the best set-up of lenses to see a clear image, again look at the nearby object and move the lenses until you get a focused image. Have your partner measure the distance between the lenses while you hold them steady. Record the distance in a sketch below.

8. How does this distance change when you look at a nearby object?

**Extend:**

- The largest refracting telescopes have a size limit. What is the cause of this? Where is the largest refracting telescope located?
- Look further into the history of the telescope: what improvements were made by Galileo? How did the telescope evolve?