Thought-Provoking Practical Physics Workshop

فِکر انگیز عملی طبیعیات

Lesson: Refraction, Lenses and the Optical Telescope

One of the five senses is that of sight, yet many of us wear spectacles to correct short sightedness and/or long sightedness. As children and even as adults, we have used magnifying glasses to read miniscule text or maps. In school, some of us have used microscopes to observe slides of human cheek cells and/or plant cells. Some of us have even looked through a telescope to observe celestial objects. All of these optical instruments, including our eyes use lenses.

Objectives

A lens is an instrument that refracts light in a certain manner. In this experiment, you have been provided with four different lenses. You will classify the lenses, determine their focal lengths, choose a magnification level and build a simple refracting telescope using any two of the lenses. You will learn some key specifications and limitations of the refracting telescope as well.

How to conduct the experiment

Apparatus: Lenses, light source, screen, chart paper, tape, cardboard, meter rule, smartphone.

1. Classify the type of lens; converging or diverging.

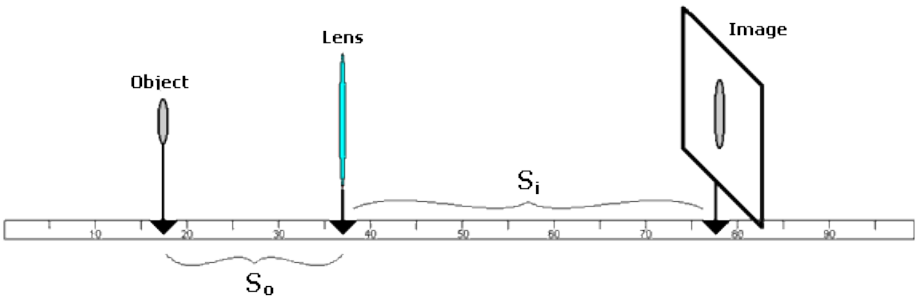

Figure 1. Calculation of Focal Length

2. Measure the diameter of the lenses and find their focal lengths using the formula

$$f = \frac{s_0 s_i}{s_0 + s_i}$$

Note. The object or light source in this case is your smartphone's torch. As long as the image focuses, the screen can be the wall, a white piece of paper or even your hand.

	Type of lens	**Diameter**	**Focal Length**
1			
2			
3			
4			

There are two types of telescopes; reflectors and refractors. Reflector telescopes use mirrors and refractor telescopes use lenses.

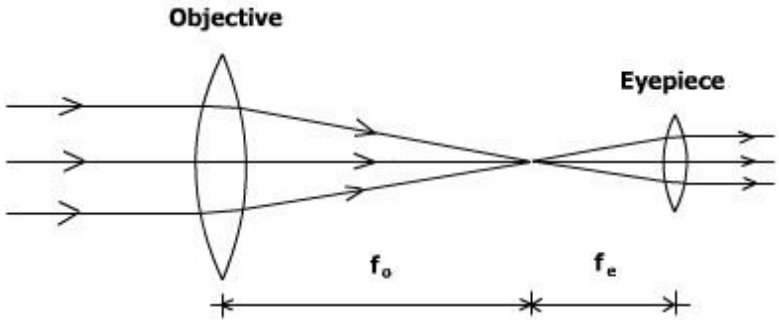

Figure 2. Simple Refractor Telescope Design

3. Choose an objective lens and an eyepiece lens.
4. The length of the assembled telescope should be slightly longer than the sum of the focal lengths of the objective lens and eyepiece lens.
5. Calculate the focal ratio (F-ratio) of your telescope by using the following formula:

$$f-ratio=\frac{focal-length-of-the-telescope}{aperture(objective-diameter)}$$

6. Calculate the magnification obtained by pairing different lenses by using the formula:

$$magnification=\frac{f_0}{f_e}$$

Where f_o is the focal length of the objective lens

f_e is the focal length of the eyepiece lens.

7. Build one or more refractor telescope(s).

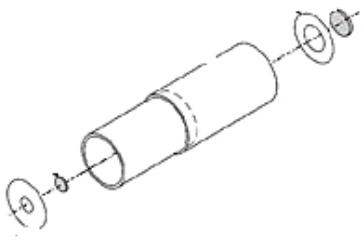

Figure 3. Suggested method of constructing the telescope

8. Calculate the resolving power of your telescope by using the formula:

$$R=\frac{116}{diameter-of-the-objective-lens(in-mm)}$$

Exploration Points

1. What do you notice when you pair different lenses together?
2. Which pair of lenses resulted in the most suitable telescope design? Why?
3. What is the orientation of the image? Can you suggest a way to make the image appear differently than it does right now?

Safety

NEVER look at the Sun using the telescope.

The lenses are made of glass and hence are fragile, please do not drop them.