Using an Optics Bench to Build a Telescope

Materials Needed—

- Optics bench
- Light source (e.g., lamp) placed far away
- Several lenses with different focal lengths; number the three convex lenses
- Ruler
- Paper with non–symmetric drawing
- Screen for displaying images
- Light box

Introduction— Making a functional telescope is more than just putting lenses in a cylinder. Which type of lens you use, and where you position them in the telescope, will determine whether you will get a clear, focused image, or one that is unclear and useless. In this exercise, you will make your own telescope using two convex lenses.

Procedure—

1. Warm up with some ray–tracing.
   (a) Use the light source in ray–box mode (three parallel lines of light) on a white sheet of paper. Place the convex and concave lenses in front of the light and trace out how the lenses bend the incoming rays.
   (b) Try using two concave lenses one after the other, two convex lenses, and various other configurations. Trace out how the light is bent.
2. Now, build a telescope using the optics bench.
   (a) Measure the focal length of the (numbered) convex lenses:
      i. Hold the screen in one hand and the lens in the other. Focus the image of the distant bright object on the screen.
      ii. Measure the distance between the lens and the screen. This is the focal length f_1.
      iii. Repeat for the other two lenses.
   (b) Tape the paper onto a wall at the same height as the optics bench so that it is easy to see.
   (c) Chose two lenses to work with. Clip in one of the lenses at the end of the bench (this is the eyepiece), directing it toward the picture. Clip in the other further down the bench (this is the primary). Look through the two lenses (with your eye close to the eyepiece) and adjust the position of the second lens until you see a clear, focused image of the picture.
   (d) Is the image smaller or larger? Inverted or upright?
   (e) Now reverse the order (primary becomes eyepiece, and vice versa). How has the magnification and orientation of the image changed?

Questions—

1. How does a convex lens bend light? How about a concave lens?
2. Which configuration of lenses can focus light? Which configuration of lenses can create outgoing parallel lines?
3. What are the focal lengths that you measured? What is the total distance between the lenses when you set them up?
4. In the first lens configuration, is the picture larger or smaller? Is the longer focal length first or second? What about for the second lens configuration?