

## Lab 2. Telescopes

### Equipment

- Telescope Kit by Project Star – one per group. [If you do not want the students to start building the telescope, hand out this kit after they have completed part III.]
- 1m ruler and small ruler
- Lenses: a small (2" diameter or so) strong and a small weaker convex lens; a small strong and a small weaker concave lens; a large (4" diameter or so) convex lens. The best strong small lenses have focal lengths of 5, the weaker ones 10 cm (15 or 20 is also fine – as long as the focal length of the concave lens is less than that of the large convex lens).
- The Sun (preferably) or a bright “distant” light bulb. (This exercise tends to become entertaining when students work outside and burn holes into the paper...)
- Optional: A real telescope (as a display at the end of class) to show what’s inside a telescope

### Mini Lecture prior to Lab

- This lab is self-explanatory. Start with the basics of lenses (Figures 4 and 11 in the Pre-Lab – stress the importance of the Pre-Lab, and that you will not go over the Pre-Labs in the future).

### Procedure and Setup

- Please make sure that the student’s finish part I in less than half an hour. (If it is a sunny day, they might get carried away burning holes into the paper...)
- In part II students often slow down considerably, but make sure they work solidly – they do not need to measure anything, just describe the image properties.
- If you can spend most time on part III – after all this is where they “discover” telescopes.
- Encourage the students to complete section (d) of part III in class. Please do not tell them how to do the drawings, try to let them figure it out for themselves. The drawing for the Keplerian Telescope is in the book, but the Galilean Telescope is not (this is the most difficult part of the lab and tests whether they understand the properties of lenses and HOW to make a telescope).

### Notes & Suggestions

- Handing out the same lenses to the entire class will make the grading much easier
- Part I becomes simpler (and more intuitive) if at least one set of concave and convex lenses have the same focal lengths (when adding 5-cm concave and convex lenses students obtain a piece of glass).
- There is a separate Do-at-Home version of this lab – it does require the telescope kit.

### General Concepts & What students might get out of this Lab

- A Feel for different types of Lenses and their Properties – at least qualitatively
- Learn what’s inside telescopes; that astronomical telescopes invert images; that a stronger objective gives more magnification – and that they can build simple telescopes by themselves.
- Understand HOW the properties of images seen through a telescope depend on the configuration, alignment, and strengths of the lenses.
- That some telescopes invert (why they do that) and why astronomers prefer this type of telescope
- Never to look at the Sun through a lens

### Scientific Methodologies

- How “playing” with lenses can lead to inventing a telescope; and more generally, what thoughts go into experimenting and making discoveries
- That making scientific discoveries depends on understanding concepts, not on using Math and plugging numbers into Formulae (though these are needed for advanced labs...)