Physics INS, Optics Lab, 05/21/04

This lab will cover geometrical optics, myopia (nearsightedness), hyperopia (farsightedness), refraction, polarization, and color perception.

## I. Law of reflection

Questions to be answered:

1. How high from the ground must a plane mirror be to guarantee that the viewer can see her feet?
2. Where must a plane mirror be positioned to guarantee that the viewer can see the top of her head?
3. How high does a plane mirror need to be to guarantee that the viewer can see her whole self?
4. How does distance to the mirror affect the amount of her body the viewer can see?

Select one lab partners as the viewer. Measure the distances from the ground to the top of her head and to her eye. You might think about using the mirror for some of this!
Move the mirror vertically up and down the wall until the viewer can just see her feet (just above the bottom of the mirror). Measure the distance from the ground to the bottom of the mirror – the *mirror*, not the frame.
Move the mirror up and down until the viewer can just see the top of her head (just under the top of the mirror). Measure the distance from the ground to the top of the mirror.
Prop or hold the mirror up, vertically against the wall. Viewer, can you see any more or less of yourself when you are closer or farther from the mirror?
We have considered these questions abstractly in class – how well does the world fit our neat-and-tidy geometrical models?

## II. Hperopia

Hyperopia, or farsightedness, is most common in old eyes. The muscles and lenses are no longer strong/flexible enough to pull images of near objects onto the retina. Images of near objects focus behind the retina.

Questions to be answered:

5. What is the focal length of just the plano-convex lens representing the eye?
6. What is the focal length of just the double-convex lens representing the corrective lens?
7. Using the above calculate the image distance for the double-convex lens in the combined set up. Convert this image distance to the object distance of the plano-convex lens and calculate its image distance. How well does this match up with data from the optics bench?

The lamp with the arrow screen should be at the 50 mm mark of the left optics bench and the blank white screen should be at the 550 mm mark of the right optics bench. throughout all of this.
Using just the plano-convex lens, move it on the bench(es) until it focuses the arrow. Carefully measure image and object distances. Calculate focal length.
Repeat for just the double-convex lens.
Set up the plano-convex lens at the 50 mm mark of the right optics bench. The arrow should be badly out of focus. Position the double-convex lens between the arrow and the plano-convex lens so the arrow focuses on the white screen. Measure the object distance for the double-convex lens using the bench, but to measure the distance between the two lenses you will have to be a little creative.

**III. <u>Myopia</u>**

Myopoia, or nearsightedness, is most common in young eyes. The images of distant objects are focused in front of the retina.

Questions to be answered:

8. What is the approximate focal length of just the plano-convex lens used to make the light rays parallel? You will have to look under the ray box.
9. Why does the diverging lens correct for myopia?

Tear off a 30 – 40 cm piece from the roll. Align it with the ray box and measure 25 cm from the edge of the ray box; Mark this point with a line perpendicular to the paper. This represents your retina. Put the plano-convex lens close to the ray box's opening so that the rays emerge from the lens parallel to one another.
Put the two double convex lenses on either side of a line 16 cm from the edge of the ray box. These represent your eye's lens. The parallel rays should go through your "eye" and focus in front of your "retina".
Put the diverging lens between the raybox and your "lens" so that the rays now converge on your "retina". Measure the distance of the diverging lens from the edge of the raybox.

**IV. <u>Kirk and Spock Go Fishing</u>**

Captain Kirk and Mr. Spock are stuck on a planet and must hunt fish (or is it matchbox cars) to survive. Kirk has a spear and Spock has a laser

Questions to be answered:

10. Explain how (and why) Kirk must aim to hit his target.
11. Explain how (and why) Spock must aim to hit his target.

## V. <u>Screens, We Don't Need No Stinking Screen</u>

Turn on the slide projector. What is the image that you see on the board?
At the point on the floor marked with tape, wave the yardstick up and down. What image do you see in the air?

Questions to be answered:

12. What role does a screen play in seeing a projected image?
13. What role does focusing play in seeing a projected image?

## VI. <u>Polarization</u>

Use the tape markers to orient the polarizers 90° with respect to one another. Leave on the overhead glass and lift the other one up, keeping them perpendicular. The projected image should be very, very dark.
Now put a third polarizer between the two and rotate it around – the three polarizers should be parallel.
What do you observe? How is that possible?