12B Lab 3A

# Optics

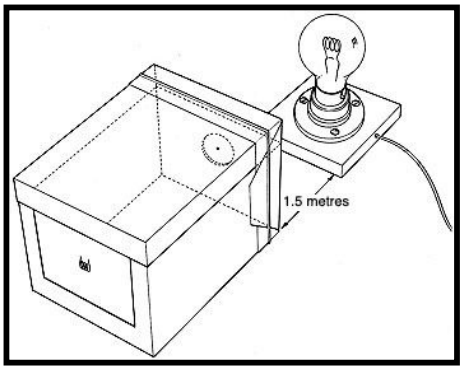
Names:
1.)
2.)
3.)

**Learning Objectives:**

- Find the index of refraction of an unknown material
- Given the index of refraction of a medium, calculate the speed of light in that medium
- Given the index of refraction of two materials, calculate the critical angle.
- Find the focal length of a lens with an object at infinity
- Find the focal length of a lens by placing the object at several locations and finding the resulting image

**Warm-up: Pinhole Camera**

The box provided has a screen on one side. Cover the other side with aluminum foil and make a small hole (<1mm) near the center. Face the pinhole towards the light source and adjust the location of the box so you can see an image of the illuminated object.




Questions:

1.) When you look at the screen what are you looking at? (Hint: Are you looking directly at the object? Discuss with your TF)

2.) Is the image upright or inverted?

3.) What happens to the image height when you adjust the distance from the light source?

4.) Draw a simple ray diagram to help illustrate what we are looking at?

5.) Find a spacing between the light source and the pinhole camera so that you get an image that is twice the size of the object. What is the image distance?

What is the object distance?

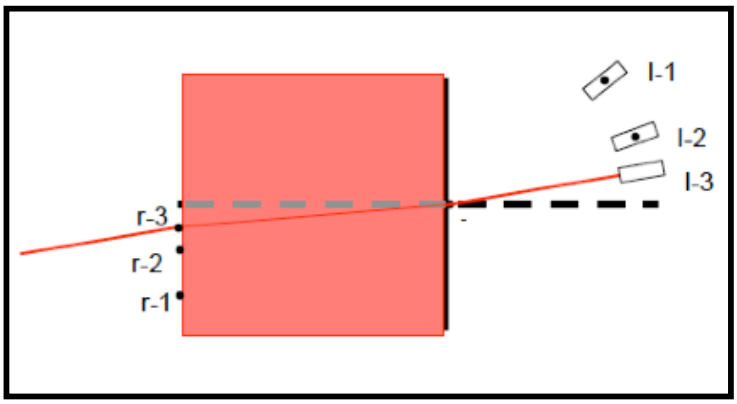
6.) What happens if we increase the size of the pinhole? Try increasing the pinhole by small increments (use a pencil) and observe what happens to the image?

7.) Draw a second ray diagram to account for a change to a large pinhole

8.) What is the benefit to a larger pinhole, and what is the drawback? (Hint: Think about image focus verses image intensity. Discuss with your TF)

**Index of Refraction: Jell-O Optics**

Caution: The laser can cause permanent eye retina damage. You should always be aware exactly where the laser is pointed and if there are any stray reflections. This activity is best kept at waist level. Never lower your head to "find" the beam. Use a piece of index card provided.




Procedure: Mark a dashed line down the graph paper. Place the container of Jell-O on the graph paper so the dashed "normal" line cuts down the center. Shine the laser pointer through the Jell-O at various angles from the normal line. Measure six incident and refracted angles. Graph this to obtain an average value for the index of refraction.

Include this graph here with your calculated index of refraction. Calculate the speed of light in the Jell-O.

Use the Jell-O or the cloudy fish tank to observe total internal reflection. State the conditions for total internal reflection and calculate the "critical angle" for your Jell-O block.

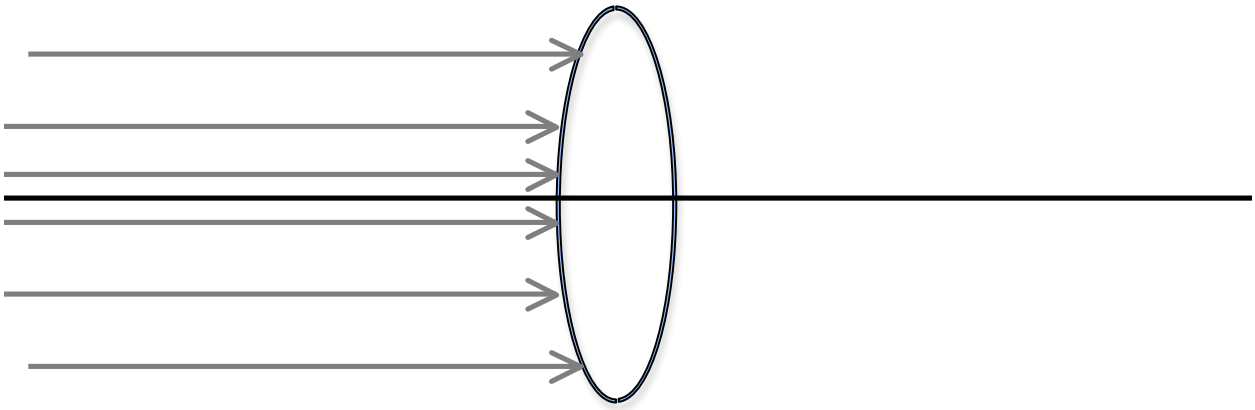
# Ray Optics:

## 1.) Measuring the focal length of a lens

A.) Measure the focal length of a lens by looking at an object at "infinity". Our object will be the light bulb at the front of the room.

The focal length of our lens is = _____meters

B.) Draw a ray diagram of what is happening with the lens. We will assume that the rays of light coming into the lens are coming from "infinity" so that it enters the lens parallel.



## 2.) Playing with the object and image distances

Take a moment to play with the following ray tracing applet:

http://phet.colorado.edu/en/simulation/geometric-optics

Now try the following experiment with equipment provided on the lab bench.

**WARNING: Be careful with the open flame of the candle. Make sure there's no loose clothing/hair.**

A.) Place the lens on the table next to a two meter stick. Move the candle to a distance away from the lens (do = object distance). Use a screen to find the image that the lens creates (di = image distance). Note that there is a minimum distance that the object can be from the lens to produce this "real image".

What was the minimum distance found to create an image on a screen?

B.) Make a table for 8 different object distances and their corresponding image distances. Choose a range of image distances that are close to the lens as well as far.

Plot the object vs. image distance results with the object distances as you independent variable. Include this graph here with labels and title.

C.) This graph does not look very linear. Can you find some manipulation of the variables that creates a linear plot? What would the slope of this line be? What does the sign of the slope mean?