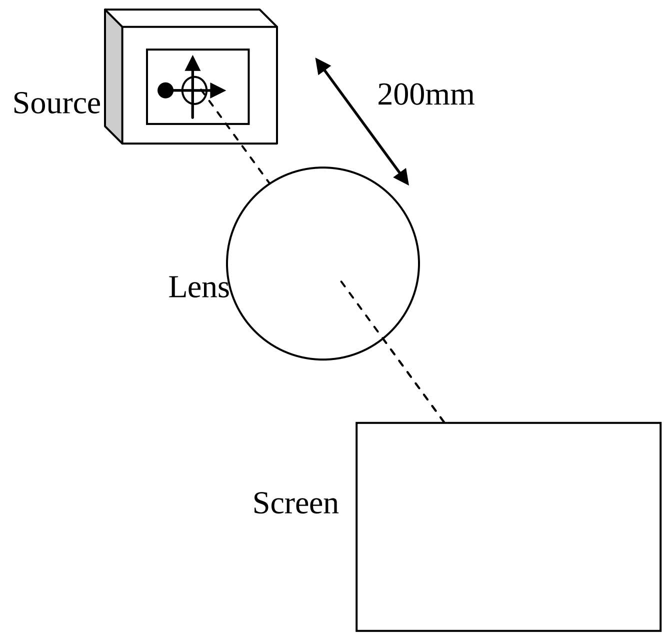
Physics 345 Pre-Lab 7

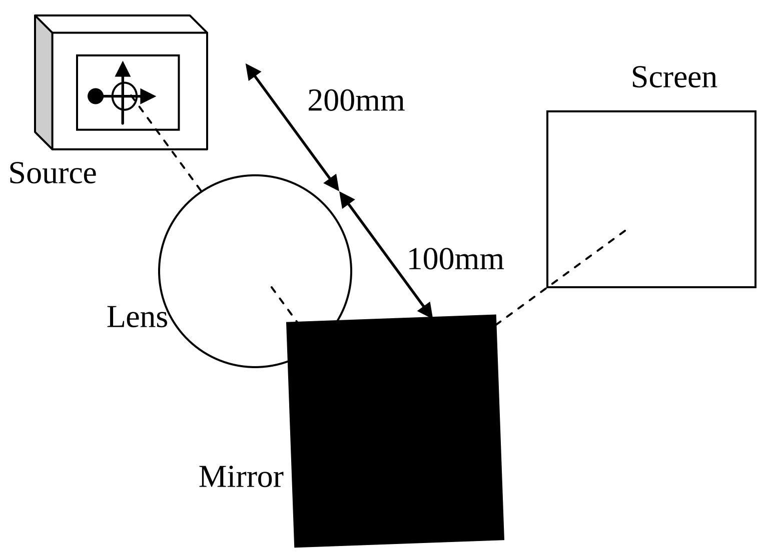
Images and reflection

Imagine that you have an extended light source with two arrows, one horizontal and one vertical. A 150 mm fl lens is placed 200 mm from the source.

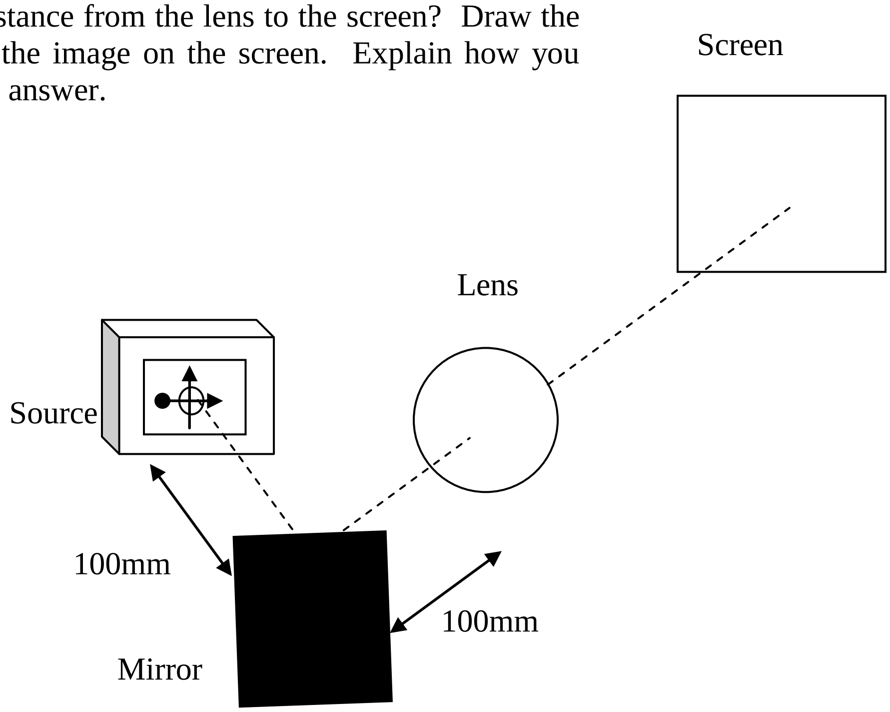
A) How far from the source will the image form? Draw a picture of the image (as seen from the back of the screen) paying close attention to its orientation.



B) A mirror is now placed 100 mm from the lens at an angle of 45 degrees as shown in the diagram to the right. This will cause a ray traveling along the optical to axis to bend 90 degrees. A screen is placed at a position so that a clear image forms on it? What is the distance from the screen to the mirror? Draw the orientation of the image on the screen. Explain how you arrived at your answer.



C) Suppose that the mirror were located 100 mm from the source and the lens located 100 mm from the mirror as shown in the diagram below. Once more the ray traveling along the optical axis reflects through a 90 degree angle. What is the distance from the lens to the screen? Draw the orientation of the image on the screen. Explain how you arrived at your answer.



Physics 345 Lab 7: Introduction to mirrors

The purpose of this portion of the lab is to familiarize you with positioning images and beams of light. You will be learning the impact that mirrors have on images. You will learn an iterative technique to position a laser beam. Many of these approaches are necessary when working with optics and lasers. Because you are going to be working with at least two dimensional setups, you will for the first time be using the optical table. As usual, care is necessary when setting up the optics. In all situations you should attempt to capture evidence of your observations using the translucent screen and the webcam with original lens attached. You will also be using quality mirrors and mirror mounts. Familiarize yourself with how the mirror mounts work and NEVER set the mirrors face down on the table.

Section 1

How does a reflection change the orientation of an image? What were the correct answers to the pre-lab?

Set up the situations from the pre-lab and test your predictions. Describe your results

Reconcile your prediction with your observations.

Section 2: Auto-collimation

In this section you will explore how to transmit light over a long distance with minimal loses.

Suppose that you wanted to have the light exiting a converging lens be collimated. How would you arrange the lens with respect to the source? Where would the image form in this situation? Explain. Describe a method to achieve this end.

One method to collimate light from a source is called auto collimation. Essentially, the lens is placed in a certain distance from the source and a mirror is placed some distance away from the lens. An image of the source should be formed on the source. Under what conditions can this happen? Explain.

Using the +150 mm F.L. lens, the 6-in. rail and cars, perform an auto collimation. The easiest method is to cover half the light source with an opaque screen.

Once you have collimated the light suppose that you placed a +200mm lens approximately 100 mm from the +150 mm F.L. lens. Predict how you would expect the image to appear. Explain.

Suppose you moved the +200mm F.L. lens so that it was 500 mm away from the first lens. Predict how you would expect the image to appear. Explain.

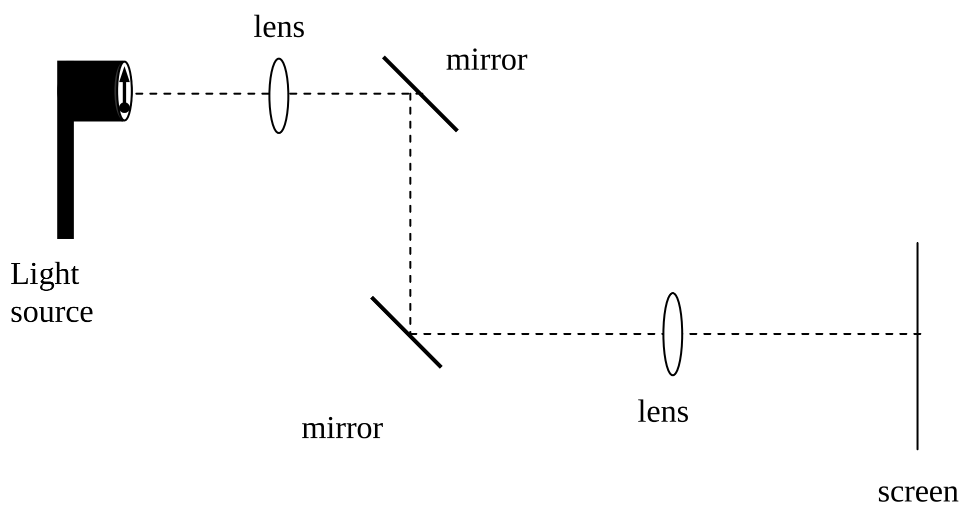
Suppose that you replaced the +200 mm F.L. lens with a 100 mm F.L. lens. How would the image appear now? Explain.

Perform these three trials and reconcile the differences between observation and prediction.

Section 3: Image positioning and distortion.

This section examines the effect on a collimated beam that reflects off several mirrors, to a lens, and finally to a screen.

Suppose that you want to send the light through two 90 degree angles as shown in the diagram below (overhead view). The lens closest to the light source is at a distances that collimates the light.



Predict the appearance of the image. Explain why you believe the image should appear this way.

Test your prediction being careful to keep the image at the same height throughout the test. Reconcile any differences between the prediction and your experiment.

Now imagine that you are trying to raise the image 5 cm from its original height. The first mirror is given a tilt upwards and as the light leaves the second mirror it is again parallel to the table, only 5 cm higher than before (the beam is once again traveling in the same direction as it was before the first mirror). How will the image on the screen appear?

Perform the test and reconcile any differences between your predictions and observations.

Section 4

Occasionally it is necessary to rotate an image through 90 (270) degrees. This section requires that you figure out how to do this.

How would it be possible to rotate an image by 90° (or 270°)? Hint: Think 3 dimensionally.

Arrange the mirrors in such a way so the image is rotated by at least 90 degrees (270 degrees would be acceptable as well). How were the mirrors arranged?

What happens to the image if the mirrors are arranged so that the beam does not leave the second mirror perpendicular to the incoming beam? How do you account for your observations?

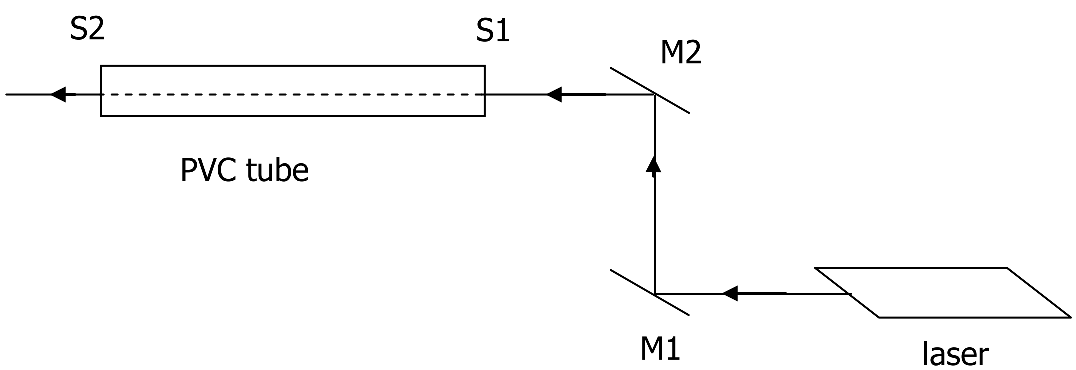
Section 5: Laser alignment

In this section you will be working with lasers. You must always terminate the beam with some sort of beam stop. In this part of the lab, each of you should be setting up a laser individually so that you all get the "feel" of how to position the beam.

It is almost always preferable to position a laser beam using at least two mirrors. The reason for this is that it makes it possible to redirect the laser beam so that it can always be parallel to the working (table) surface. The two mirrors allow you to change horizontal and vertical positioning accurately.

For your first laser alignment task, you will have to get the laser through a 30 cm long, 1.3 cm diameter copper pipe. This pipe represents some sort of oven through which the laser beam must travel. Using two mirrors and the laser get the beam through the pipe without hitting the sides of the pipe.

The easiest way to perform the adjustments is through an iterative approach. Since you have two mirrors and two locations through which the light beam must pass you have to determine which mirror to adjust. Consider the drawing shown below. The best approach would be to adjust mirror M1 for the laser beam's location at S1 and mirror M2 for the laser beam's location at S2. Any other ordering of mirror adjustment will often result in an inability to get the beam to behave in a way that is reasonable. Why is that? Explain.



Final Task

Given the obstacle course you must position a laser beam through the three apertures with a minimum number of mirrors and in a minimum amount of time.