Optics Day1
Basics
(Philbert Tsai – July 2004)

Hook up the lamp

Mount the lamp housing onto a post.

Mount a post holder onto a base plate with a 1/4-20 screw

Mount the post holder/base plate to a rail carriage with a 1/4-20 screw and a washer

Connect the lamp housing to the power supply – this bulb should be able to handle the full 3 amps from the power supply

Set up 2 lens holders, 1 aperture, and a card holder

Mount 4 more post holders to base plates and rail carriages, as above.

Mount 2 lens holders to posts using 8-32 screws

Place an index card into the sample clip to use as a viewing screen

Find and mount a diaphragm aperture

Align the lens holders

Define an optical axis, and align the optical elements to that axis:

Place the index card near the light source, and place the aperture between the two.

Close down the aperture, and mark the center of the spot on the card with a pencil

Move the card to the far end of the rail

Insert a long focal length lens into a lens holders positioned between the aperture and the card

Adjust the positions to get an image of the aperture on the card.

Adjust and tighten the position of the lens to center the image onto the mark.

Repeat for second lens holder.

Single Positive Lens Imaging
Test your intuition.

Using either the lamp filament itself, or the mask of the letter "P" as your object, create an image with a single positive lens, f, on the screen. Guess/calculate the position and size of the image as you vary the distance of the lens to the object.

Try putting the lens a distance of 2*f away from the object

Try these other distances : 1.33*f , 1.5*f , 3f , 4f

Q: What is happening to the image position/size as the object-lens distance gets very large

Q: What is happening as the object-lens distance approaches f

Virtual Images
Q: What will happen when the object-lens distance is LESS than f

Try setting the object-lens distance to 0.5 f. Do the calculation (or perform the ray trace).   Where do you expect to find the object, what size should it be? Is it inverted or upright? Set up the lenses in this way. How can you see this virtual image?

Two Positive Len

Back to Back Lenses

According to the textbooks : two (thin) lenses placed back-to-back will act as single lens with a focal distance of : $(1/f_{total}) = (1/f_1)+(1/f_2)$. Test this formula with some lens combinations.

Q: What happens when you put a +50mm lens back-to-back with a –50mm lens? Try it. Look by eye.

Using two lenses, you can use the image created by the first lens as the new object for the second lens:

Real Image as an object

Use a positive lens to create a real image onto a card. Use this card position as a new object for a second positive lens. Move the card to the expected position of the new image.

Virtual Image as an object

Use a positive lens to create a virtual image (remember how to do this?) Calculate where the image is. Use a second positive lens to generate a real image of this new (virtual) object.

Beam Expander

Mount the laser pointer onto a rod, and shine it down the optical axis.

Try to expand the beam using two positive lenses. Pick two lenses. Calculate the separation you need to re-collimate the laser beam.   Calculate the magnification of the beam size.

Try to expand the beam using a negative followed by a positive lens.

Q: What is the advantage of this method over the first method? (Hint: Think about high-powered lasers)