PART 1
On the left you have the image and on the right you have the image. The image could be seen on a screen. Click on the help sign. You can now see the 2 focal points. The distance between the center of the lens and the cross is called the focal length.

Change (slide the cursor) the index of refraction (refractive index) of the glass that makes up the lens. How does changing the index affect the focal distance? Explain why is that?

hint: remember large index means more bending of light.

Now change the thickness of the lens by changing the curvature. What is happening to the focal distance?

Go back to curvature = 0.8 and index=1.53
click on the ruler and measure the focal length (between the lens and the cross) = f = __________ cm
Place the object (the pencil on the left) at a distance = 1.5 f from the lens. (or anywhere between f and 2f)
Describe the image (on the right):
Is it enlarged? or reduced?
Is it upright? or upside down?

Now Move the object away from the lens at a distance larger than 2 f. What is happening to the image?

As you move the object farther and farther away, the image (right side) gets closer and closer to the ______ ______.
When the object is placed at infinity, the image is formed in the focal plane.

Now let's do some math to derive the lens formula.

Use the ruler to place, carefully, the object at a distance o= 120cm from the lens. Be very precise.
With the ruler, measure the distance between the lens and the image. i = _________.
The focal distance should be the same as before f = _________.

Compare 1/f = ________ to 1/i + 1/o

Conclusion? This is called the lens formula/

Click on many rays. Observe the paths of the rays. Why the lens is called a converging lens?

To draw an image, for a given object, you just need to draw 2 or 3 rays.
Click on principal rays. Observe the 3 rays coming from the object. From top to bottom:
the top ray is // to the principal axis and after going through the lens, is bent toward the ________ ________.
The second ray goes straight through the center and is not bent
The bottom ray goes through the focal length before the lens and after going through the lens travels // to ____________.

Using these 3 rays you can draw the image of any object. Using this principle draw the image of the tree below.
Trace the 3 rays. To help you: [http://cnx.org/content/m39026/1.1/?collection=col11241/latest](http://cnx.org/content/m39026/1.1/?collection=col11241/latest) see figure 9.

PART 2

Now move the object between the lens and the cross. So i < f. What is happening to the image? Can you see it? The image can be no longer seen on a screen. It becomes “virtual “ and you are using the lens as a magnifying glass. **click on virtual image.** Can you now see the image? It can’t be seen on a screen but it can be seen by our eyes. What so special about the image? Is it upside down as before?

Is it reduced or enlarged? You can move the object inside the focal distance.

Place the object between the lens and the cross so you get a virtual image. Carefully measure:
f = __________ cm (with ruler)
o = __________ cm (with ruler. It is the distance between the center of the lens and the object).
You should have o < f. Let's use the formula \(1/f = 1/i + 1/o\) to solve for i. First you solve for \(1/i\) then you take the reciprocal. Do the math:

\[i = \text{_______ cm. Do you get a negative number? Does that make sense?}\]

Measure the experimental value for i. With the ruler, the measure the distance between the lens and the enlarged image. i_{exp}= _______. Compute the % error = \(|i-i_{exp}| / i \times 100\) = _______.

PART III

Go back to the first setting. The object is at a distance i > 2f. Decrease the diameter of the lens. What is happening to the image?
Select many rays. Observe. Explain why the image is dimmer?

CONCLUSION OF THE LAB