Lab 8 – Microscope

Name _____

I. Introduction/Theory

The purpose of this experiment is to construct a microscope and determine the magnification. A microscope magnifies an object that is close to the microscope. The ray diagram for this experiment (Figure 1) indicates that the image is in the same plane as the object. Having the image in the same plane as the object allows the distance to the virtual image to be determined. For this experiment, it is assumed that the lenses are thin compared to the other distances involved. In this case the Thin Lens Formula may be used. This equation states $\frac{1}{f} = \frac{1}{o} + \frac{1}{i}$, where f is the focal length, o is the object to lens distance, and i is the image to lens distance. The magnification of a two-lens system is equal to the multiplication of the magnifications of the individual lenses:

$$M = M_1 M_2 = \left(-\frac{i_1}{o_1}\right)\left(-\frac{i_2}{o_2}\right)$$

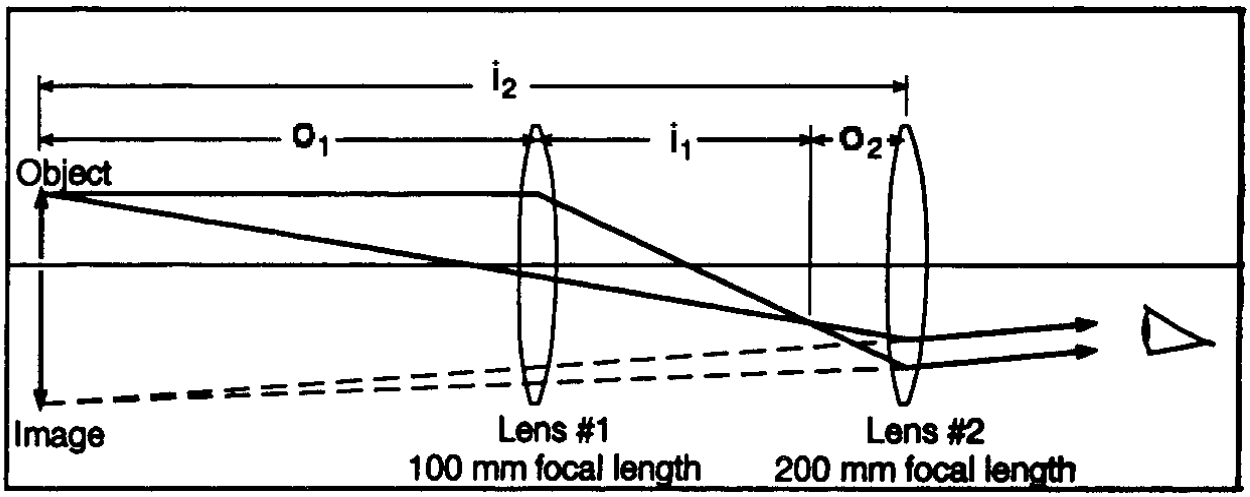

Figure 1

II. Equipment

Optical Bench
2 Convex Lens
Grid Pattern
Screen
Ruler

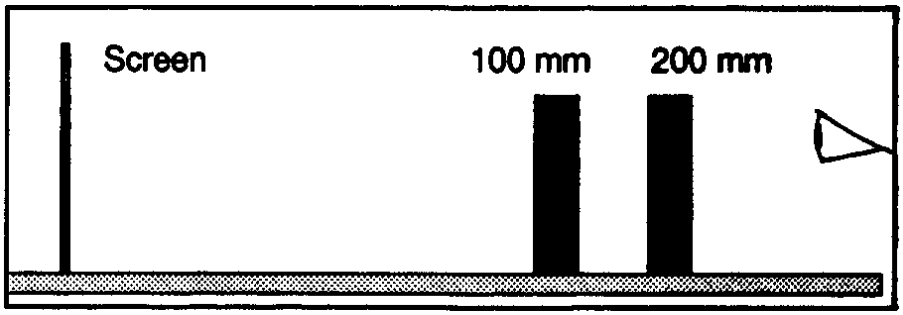

Figure 2

III. Procedure/Data

1. Tape or use paper clips to fasten the paper pattern/grid to the screen. The crosshatching of the screen acts as the object.
2. The 10 cm lens is the objective lens (the one which is nearer to the object). The 20 cm lens is the eyepiece lens (the one which is nearer to the eye). Place the lenses near one end of the optical bench and place the screen about in the middle of the optical bench. See Figure 2.
3. Focus the image of the object (the crosshatching on the screen) by moving the objective lens(the one which is closer to the object). To view the image, you must put your eye close to the eyepiece lens. NOTE: a good microscope has $o_1 > f_1$, but not by much ($o_1 \cong 2f_1$)!
4. Eliminate the parallax by moving the eyepiece lens until the image is in the same plane as the object (screen). To observe the parallax, open both eyes and look through the lenses at the image with one eye while looking around the edge of the lenses directly at the object with the other eye. See Figure 3. The line of the image (solid lines shown in Figure 4 inset) will be superimposed on the lines of the (shown as dotted lines in figure 4 inset). Move your head back-and-forth or up-and-down. As you move your head, the lines of the image will move relative to the lines of the object due to the parallax. To eliminate the parallax, move the eyepiece lens until the image lines do not move relative to the object lines when you move your head. When there is no parallax, the lines in the center of the lens appear to be stuck to the object lines. NOTE: even when there is no parallax, the line may appear to move near the edges of the lens because of lens aberrations.

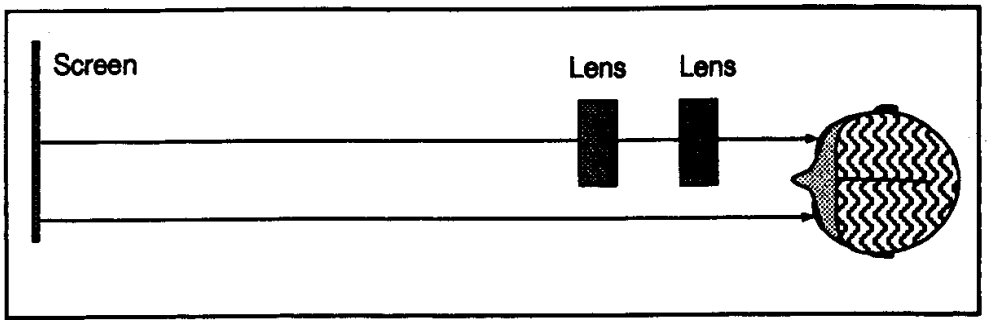

Figure 3

5. With the parallax now eliminated, the virtual image is now in the plane of the object. Record the position of the lenses and the object in Table 1.
6. Measure the magnification of this microscope by counting the number of squares in the object that lies along one side of one square of the image. To do this, you must view the image through the microscope with one eye while looking directly at the object with the other eye. Record the observed magnification in Table 1.
7. Complete Table 1:
   a. Determine o_1, the distance from the object (paper pattern on screen) to the objective lens.

b. Determine i_2, the distance from the eyepiece lens and the image. Since the image is in the plane of the object, this is also the distance between the eyepiece lens and the object (screen).
c. Calculate i_1 using o_1 and the focal length of the objective lens in the Thin Lens Formula.
d. Calculate o_2 using i_2 and the focal length of the eyepiece lens in the Thin Lens Formula.
e. Calculate the magnification using: $M = M_1 M_2 = \left(-\frac{i_1}{o_1}\right)\left(-\frac{i_2}{o_2}\right)$.

Position of Objective Lens	
Position of Eyepiece Lens	
Position of the Screen	
Observed Magnification	
O_1	
i_2	
i_1	
O_2	
Calculated Magnification	

Table 1

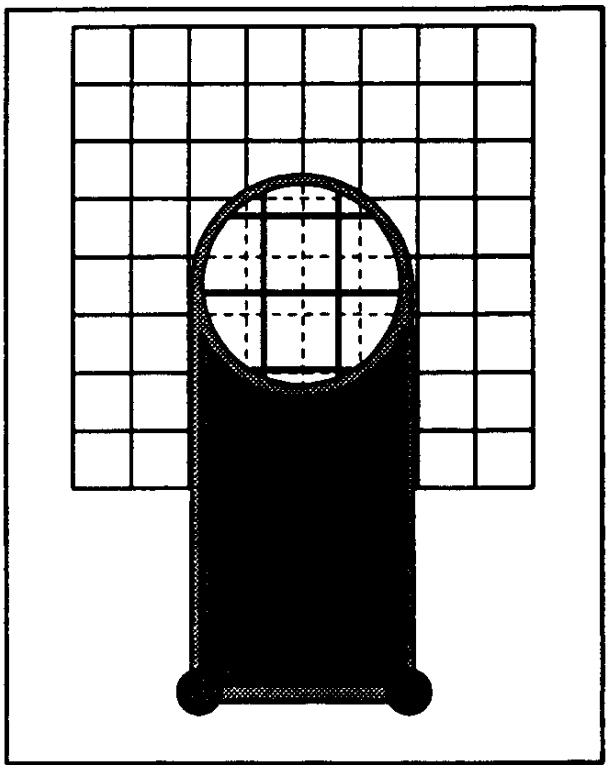

Figure 4

IV. Analysis

1. Is the image inverted or erect? Explain how you know this.

2. Is the image seen through the microscope real or virtual? Explain why this is.

3. Compare and comment on the two values of magnification found in this lab.

V. Conclusions (include physical concepts and principles investigated in this lab, independent of your experiments success, and summarize without going into the details of the procedure.)

Grid