Pre-Lab Report

Lab section:

Name & Surname:

Table #:

***Before the Lab* complete this page YOURSELF! Hand it in *in the first 5 min*. of the session PERSONALLY!**

You MUST justify your answers and show all steps. NO COPYCAT answers, or NO credits!

Please read the relevant presentation on PHYS LAB Website.

Q1. Write down the lens equation. Give the definitions of elements in the equation.

(2nd Question is on the next page!)

Q2. Use Euclid geometry to derive the relation $R = \frac{D}{2} + \frac{A^2}{6D}$ for spherometer. **Show your calculations below <u>explicitly or no credits</u>!**

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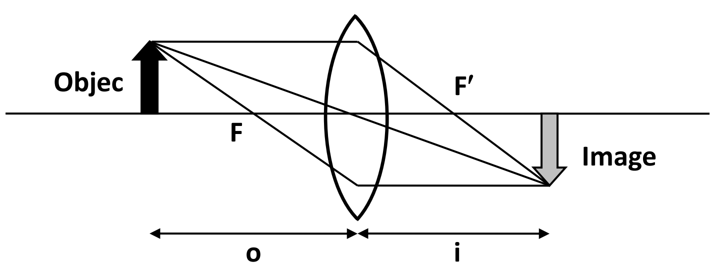
***Complete this report YOURSELF except DATA taking parts! Use a pencil for plots only and a pen for the rest!* Show your work clearly, NO COPYCAT analysis allowed, or NO credits!**

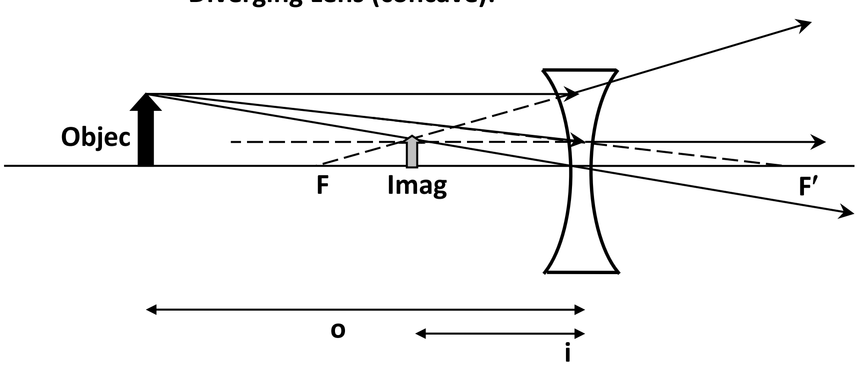
OBJECTIVE : To determine the focal lengths, radii of curvature and index of refraction of various lenses, and to investigate image formation by lens combinations.

THEORY : A thin lens is defined as a lens whose thickness is much smaller than its focal length. Thin lenses that are thin at the edge and thick at the center bend the light rays toward the optical axis (converging lenses) and those that are thick at the edge and thin at the center bend the light rays away from the optical axis (diverging lenses).

Converging Lens (convex):



Diverging Lens (concave):



Thin lenses have two basic equations, the lens equation,

$$\frac{1}{f} = \frac{1}{o} + \frac{1}{i}$$

and the lens maker's equation:

$$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

where r1 and r2 are the radii of curvatures of each surface. If both surfaces have the same curvature, the lens maker's equation becomes

$$\frac{1}{f} = \pm(n-1)\frac{2}{R}$$

where plus and minus signs are for converging and diverging lenses, respectively.

The sign conventions for the quantities used in the equations above are as following:

1. The image distance is positive if the image is formed on the right side of the lens and negative if it forms on the left side. We assume that the light source is on the left.
2. Similarly, the object distance is positive if the object is on the left side of the lens and negative if it is on the right side. (If the object is actually an image from another lens, it may be on the right side.)
3. The radii of curvatures are positive if the corresponding center for a surface is on the right side. This is the reason for positive and negative focal lengths for converging and diverging lenses.
4. The magnification m, which is the ratio of the image size to the object size, is m= -i/o. To denote the inverted images a minus sign is added.

Spherometer:

Spherometer is an instrument to determine very small thicknesses and the radius of curvature of a surface. First you should place the spherometer on a level surface to get a calibration reading (CR). You turn the knob at the top until all four legs touch the surface. When the middle leg also touches the surface, the knob will first seem to be free and then tight. The reading at this position will be the calibration reading (CR). Then you should place the spherometer on the curved surface and turn the knob until all four legs again touch the surface. The reading at this position will be the measurement reading (MR). You will read the value from the vertical scale first and then the value on the dial will give you the fraction of a millimeter. Then you can calculate the radius of curvature of the surface as:

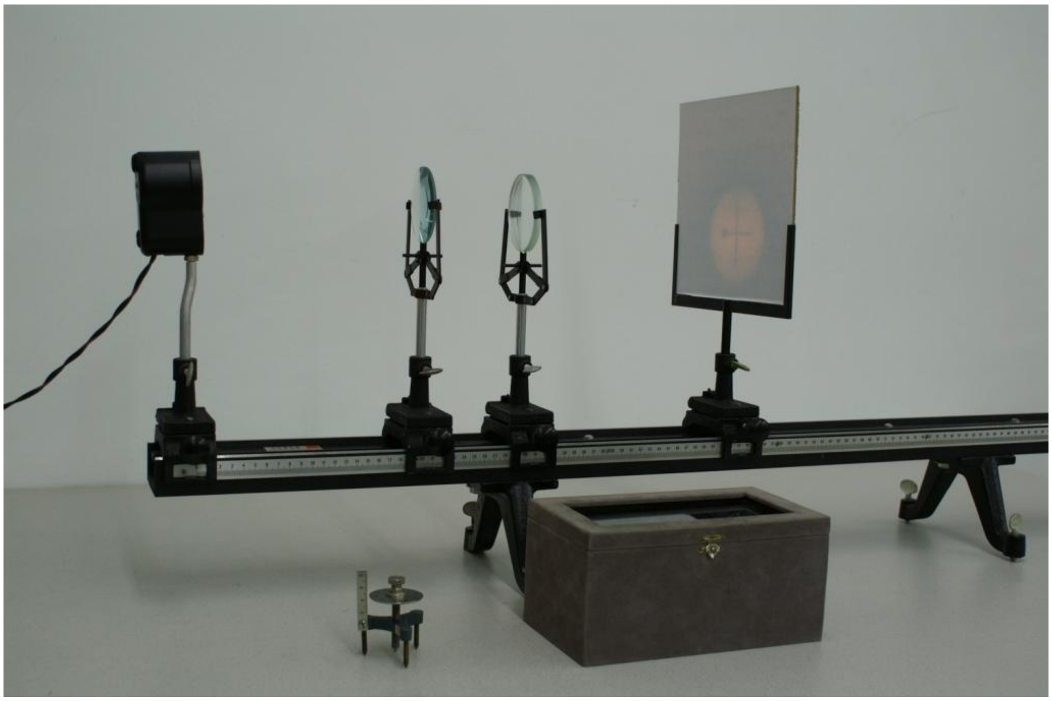
$$R = \frac{D}{2} + \frac{A^2}{6D}$$

where D = |CR-MR| and A is the distance between the outside legs.

APPARATUS : Various thin lenses, light source and cross object, ruler, screen, spherometer.

PROCEDURE :

1. Mount large and small converging lenses one by one. Adjust the position of lenses and the screen to obtain a very sharp and clear image of the illuminated cross. By measuring object and image distances for two different positions of lenses, calculate focal length and magnifications of lenses separately.



2. Use the two converging lenses to form an image of the object. Measure the image distance from the nearest lens and calculate this distance from the lens equation applied to each lens. Repeat this using converging lens of known focal length and a diverging lens. Calculate the focal length of the diverging lens.
3. Measure the radius of curvature of any large lens by a spherometer. (R1=R2=R). Determine the refractive index of the lens.

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PART – 1: CONVERGING LENSES

A) Small Converging Lens:

Object distance o_1 = ... Object distance o_2 = ...

Image distance i_1 = ... Image distance i_2 = ...

Focal length f_1 = ... Focal length f_2 = ...

Magnification m = ... Magnification m = ...

Average focal length $f_{average}$ = ...

B) Large Converging Lens:

Object distance o_1 = ... Object distance o_2 = ...

Image distance i_1 = ... Image distance i_2 = ...

Focal length f_1 = ... Focal length f_2 = ...

Magnification m = ... Magnification m = ...

Average focal length $f_{average}$ = ...

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PART – 2: LENS COMBINATION

C) Two Converging Lenses:

Draw the diagram of the system:

<u>Measure</u>:

Object distance

for the first lens o_1 = ...

Image distance

for the second lens i_2 = ...

Distance between the lenses d = ...

<u>Calculate</u>:

Image distance

for the first lens i_1 = ...

. . . .

Image distance

for the second lens i_2 = ...

. . . .

% Error for i_2 = ...

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D) **Large Converging & Large Diverging Lenses:**

Draw the diagram of the system:

Measure:

Object distance

for the first lens o_1 = ...

Image distance

for the second lens i_2 = ...

Distance between the lenses d = ...

Calculate:

Image distance

for the first lens i_1 = ...

. . . .

Focal length

of the diverging lens $f_{\text{diverging}}$ = ...

. . . .

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PART – 3: SPHEROMETER

True Value of the

Index of Refraction n_{TV} = ...

Distance between the legs A = ...

Calibration reading CR = ...

Measurement reading MR = ...

Difference in readings $D = \left| CR - MR \right|$ = ...

. . . .

Radius of curvature

of the lens surface $R = \frac{D}{2} + \frac{A^2}{6D}$ = ...

. . . .

Index of Refraction n_{cal} = ...

. . . .

% Error for Index of Refraction, n = ...

Consult to the resources for this experiment from PHYS LAB Website:

PHYL202 Intro

Presentation #4

PHYL202 Lab Book

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