Image Formation by Thin Lenses

PURPOSE:

To determine the focal length of two converging lenses and one diverging lens by using and optical bench and applying the lens formula.

EQUIPMENT

- Optical bench
- Two converging lenses
- One diverging lens
- Holders and bases
- Illuminated Source.
- Target

PROCEDURE:

Choose two converging lenses with different focal length. Label one as "Long focal length" and the other as "short focal length". Determine the focal length of each one use the following steps.

1. Set the optical bench as shown on the front table.
2. Use the illuminated source as the object.
3. Record the position of the object on the optical bench. **(Notice that there is a ruler on the side of the optical bench)**
4. Set the converging lens on the holder and while holding the white cardboard adjust the position of the lens until you get a clear image on the cardboard.
5. Record the position of the lens.
6. Record the position of the image.
7. From steps 3 and 5 obtain the distance between the source and the lens. Call this distance **s**.
8. From step 5 and 6 obtain the distance between the lens and the image . Call this distance **s'**.
9. Repeat steps 1 through 8 for the other lens. **Remember you are going to need two values for each lens.**

Next you are going to work with the divergence lens and the "Long focal length" lens to find the focal length of the divergence lens.

10. Place the illuminated object at zero on the optical bench.

11. Place the "long focal length" lens 30 cm from the object.

12. Find the location of the image for this system by using the white cardboard. If the image is outside the optical bench, measure the distance between the lens and the image. Otherwise, just record the positon of the image.

13. Now without moving the source or the converging lens, place the divergence lens **15** centimeters from the converging lens.

14. At this point your source should be at zero, your converging lens should be at 30 and your diverging lens should be at **45**. **Check your positions.**

15. Using the white cardboard to find the image. Record this position.

CALCULATIONS:

1. Find the focal length of the two converging lenses by using the Thin - lens equation.

$$1/f = 1/s + 1/s'$$

where:

s is the distance from the source (object) to the lens in centimeters
s' is the of the image distance from the lens in centimeters
f is the lens focal lens in centimeters.

2. Calculate the percent error for each lens by using **14.5** cm and **5.0** cm as the theoretical values for the focal lengths.

3. Find the focal length of the diverging lens as follow.

    a. Find the position of the object for the diverging lens by subtracting the position of the converging lens image minus the position of the diverging lens. **You need to assign a negative value to this distance** since the object is on the back side of the lens. This is the **s** for the divergence lens.

    b. Calculate the image distance using the position of the lens and the image. This distance has a positive value since is on the back side of the lens.

    c. Use the lens equation again to determine the focal length of the divergence lens. This focal length value must turn out to be a negative number, and this should come out of the formula automatically.

4. Calculate the percent error for the divergence lens' focal length. Use -20.0 cm (notice this is negative 20) as the theoretical value.