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Physics 132 Section ML

Room 212

Due Date: 2.20.14

Verifying Laws Associated with Reflection, Refraction, and Different Types of Lenses

Abstract

Lasers allow for different properties of light to be studied more readily in the classroom. In this lab we were able to observe how light reflects off of surfaces and refraction. We also observed how converging and diverging lenses differ in terms of images produced – whether they are real or virtual and whether they are inverted or upright.

Questions

1. Use your data to verify the Law of Reflection and then use Snell's Law to calculate the refractive index for water (n_w). Compare it with the known value given in the manual.
    a. The Law of Reflection is $\theta_1 = \theta_2$. We measured the angles of two lasers during lab to prove that this law was true. For the first laser both θ_1 and θ_2 were equal to 30°. For the second laser both θ_1 and θ_2 were equal to 40°. We were able to measure the angle of the laser using a protractor and we were able to see the lasers' reflections using incense. Snell's Law is $n_{air} * \sin\theta_1 = n_w * \sin\theta_2$. For the first laser the variables used were $\theta = 23°$ and $n_1 = 1.00029$ to give us $n_2 = 1.28$. The actual amount for n_2 was 1.33 to give a percent error of 3.8%. For the second laser the variables used were $\theta = 35°$ and $n_1 = 1.00029$ to give us $n_2 = 1.12$.
2. What is the focal length of the lens used in section 2.3 "Focal Length" of your manual? Can you deduce form the image seen, if the lens used was converging or diverging?
    a. The focal length of the lens used in section 2.3 "Focal Length" of the manual is 10.5 cm. The image seen allows me to deduce that this was a converging lens.

3. Calculate the focal length of the given converging lens based on the measurements of s and s' and thin lens equation. Tabulate your results (for all the three trials). Compare ratios of the image and object distances and heights for the three object distances to show –(s'/s)=(h'/h) is true. Draw a ray diagram and show the different lengths for one trial. Section 2.3 "Real Images" in your manual.
   a. The thin lens equation is 1/s + 1/s' = 1/f. The first measurements obtained in the lab give s= 13 cm and s' = 37 cm to give f = 9.62. This would give a percent error of 8.38%.
   b. We obtained data for three object distances to show that –(s'/s)=(h'/h) is true. The first measured data was s=13 cm, s' = 37 cm, h = 3.9 cm, and h' = 9.2 to give a ratio of -2.84 : - 2.35. The second data set yielded s = 15 cm, s' = 31 cm, h = 3.9 cm, and h' = 8.3 cm for a ratio of -2.0667 : -2.128. The third data set yielded s = 19 cm, s' = 21.5 cm, h = 3.9 cm, and h' = 4.5 cm for a ratio of -1.13 : -1.15. All of the ratios obtained are nearly equal to each other.
   c. See attached paper for ray diagram.
4. Use the parallax method described in the lab manual to determine the focal length of the lens. Compare this length to the previously calculated values.
   a. The parallax method requires using a pin and looking directly toward the lens from the side opposite the object The pin and object shouldn't move with respect to one another, instead the image should shift relative to the pin in the direction of motion. To calculate this I used s = 25 cm and s' = 16.5 cm to find f to equal 9.94, a percent error of 5.4%.
5. Describe the virtual image seen in Section 2.3 "Virtual Image" (observing an object through a converging lens). Is the image larger/smaller than the object? Is the image upright?
   a. The virtual image seen in section 2.3 "virtual image" was larger and inverted.

6. Use: s=15 cm and f=-10 cm to calculate s'. Show/explain why it is not possible to get a real image using your diagram and the equations above. Section 2.4 "Diverging Lens".
    a. Using s=15 cm and f=-10 cm, s' = 30. It is not possible to get a real image using the diagram and equation above because diverging lenses never produce real images, a different strategy needs to be used in order to calculate focal length.
7. Calculate a value for f_D (the focal length of the diverging lens) using the method described in Section 3.4 "Lens Combinations" of the lab use the lenses as one lens, and thin lens equation to find $f_{combined}$ then use $1/f_{combined}=1/f_c+1/f_D$ to find f_D. Would this experiment be possible if $f_c>|f_D|$?
    a. The f_D = -25.07. This was found using the formula $1/f_{combined}=1/f_c+1/f_D$ where $1/f_{combined}$ = 16.47 (s= 28 cm and s' = 40 cm) and $1/f_C$ = 9.94 (calculated using parallax method). This experiment would not be possible if $f_c>|f_D|$.
8. You have a lens with a focal length of 35 cm. You need to combine this lens with another, in contact, to make a combination lens with a focal length of 15 cm. What focal length should you choose for the second lens?
    a. I would choose a focal length of -26.25 cm. I calculated this answer using the formula $1/f_{combined}=1/f_c+1/f_{D.}$

Conclusion

We verified scientific laws such as the law of reflection, Snell's law, thin lens equation, and the parallax method. We were able to do so using lasers and different types of lenses such as converging, diverging, and a combination of the two. We used variables such as s, s', h, h', f, $f_{combined,}$ f_D, f_C and others to confirm these laws.