Young's Double Slit Lab

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December 9, 2022

Purpose

The purpose of this lab was to measure the wave length (λ) of a laser travelling through a slit, then calculate the error percentage produced by our result.

Materials

- **One** Slit
- **One** Line of Measuring Tape
- **One** Red Laser
- **One** Projector
- **Two** Rulers
- **One** Piece of Paper

Procedure

1. The sheet of paper was taped to the black-board.
2. The laser was positioned infront of the slit, both facing the piece of paper on the black-board.
3. Using a pencil, the blocks made by the laser and slit were marked on the piece of paper.
4. The distance between the middles of two blocks made by the laser and slit was measured. (Δx)
5. The distance from the slit to the black-board was measured. (L)
6. The width of the slits' double-line was measured using the projector, two rulers, and the slit itself. (d)

Observations

During our experiment, our group made the following observations. Below exhibits the distance from the slit to the black-board (L) and the distance from the middles of two blocks projected by the laser travelling through our slit. (Δx)

$\rightarrow \quad L \approx 73cm \approx 7.3m$

$\rightarrow \quad \Delta x \approx 0.7cm \approx 7.0 \times 10^{-3}\ m$

$\rightarrow \quad Theoretical\ \lambda \approx 6.53 \times 10^{-7} m$

Calculations: Solve for d

Before solving for λ, we must find d (the width of the slit). To do this we used a projector (magnifier) and the formula below.

$$\therefore\ d\ =\ \frac{(1mm)(slit\ width\ on\ projection)}{(1mm\ on\ projection)}\ =\ \frac{(1mm)(3.2mm)}{(6.1mm)}\ \approx\ 5.24\times\ 10^{-4}m$$

Calculations: Solve for λ

After finding d we can solve for λ by substituting our previous variables into the following equation.

$$\therefore\ \lambda\ =\ \frac{\Delta\ xd}{L}\ =\ \frac{(7.0\times\ 10^{-3})(5.24\times\ 10^{-4})}{(7.3)}\ \approx\ 5.02\ \times\ 10^{-7}m$$

Calculations: Error Percentage

After solving for our experimental result, we use the error percentage formula to find how accurate our results really were.

$$\therefore\ Error\ \%\ =\ \left(\frac{Experimental\ -\ Theoretical}{Theoretical}\right)\ \times\ 100$$

$$\therefore\ Error\ \%\ =\ \left(\frac{(5.02\ \times\ 10^{-7})\ -\ (6.53\ \times\ 10^{-7})}{(6.53\ \times\ 10^{-7})}\right)\ \times\ 100\ \approx\ 22.97\ \%$$

Sources of Errors

1. The blocks projected by the laser travelling through the slit were too close together. This made measuring the distances far harder and far more inaccurate.
2. Measuring from the projector made achieving accurate results far more difficult due to how large and pixelated the projection is.
3. The laser was too far away / too close to the the slit.

Solutions to Errors

1. Move to a larger space so we can station the materials accordingly.
2. Use a higher resolution projector or have each of our group members measure values then calculate the average of the results.
3. Measure an appropriate seperation distance between the laser slit.

Questions

1. How would changing the laser light from red to green affect the different variables of this experiment?
Changing the laser light from red to green would affect the different variables of this experiment because the color of the wave is dependant on it's wavelength (λ). Thus, since the red laser light has a longer wavelength than the green laser light, switching to green would produce a much smaller λ

2. How would increasing the separation of the slits affect the different variable of this experiment?
Increasing the seperation of the slits (d) affects the different variables of this experiment since light waves must overlap to have interference. This means having too large of a slit would not produce enough overlap and too small of a slit would not let enough light through. This directly affects the distance between the middles of blocks projected by the laser light (Δx).

Conclusion

By the completion of this lab, it was determined that the wave length (λ) of a laser travelling through a slit was approximately $5.02 \times 10^{-7} m$ with a calculated error percentage of approximately 22.97 %.

Since our experiment had utilized a red laser, our resulting wave length (λ) should have ranged between $\approx 6.2 \times 10^{-7} < \lambda < 7.5 \times 10^{-7}\ m$