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Course: Physics 208

Section: ST5

Lab #3: Wave Optics

In this lab we will find out the wave nature of light. The principle of superposition applies to the interference of light such that two waves can be applied using their amplitudes. The maximum amplitude for both waves is twice the amplitude while the minimum is negated. We therefore investigate how these waves travel at different distances before the combine together.

Procedure:

In this lab we are given several materials like an optics track, one screen with holder, a slide holder, two slides with slits, one laser source, an incandescent source, an index card, a digital caliper and a ruler. First, we examine a white light as it passes through an aperture and projects onto a screen at the end of the track. We created this from a piece of paper. We then use a monochromatic light source, specifically a laser to investigate what happens when the light passes through the slit. Using these experimental setups, determine the wave properties of light.

Questions and Data:

1. In your own words: explain the difference between coherent and incoherent sources? Do some research and find some examples of coherent and incoherent wave sources.

Incoherent sources will have two wave sources that constantly change in phase difference. Examples of incoherent waves sources are fluorescent tube lights and tungsten filament lamps. Coherent sources occur when the photons within the beam are changing phase at the same time. Examples are lasers and speakers.

1. Include responses to the following questions with your graphs of intensity. Are the maximum intensities the same for each slit? Explain why the maximums could be different values. Are the widths of the intensity profiles the same? How do they differ? Are the edges of the intensity profiles sharp? or smooth?

The maximum intensities varied based on each slit. The slit was of different widths which affected the light or essentially waves that could pass through. Some of the slits have sharp edges but slits with smaller widths were blurrier when projected on the screen. Therefore the variation of the widths of the slits affected the intensity when spread out on the screen.

1. Explain the difference between monochromatic and polychromatic light. Give examples of each kind. Why are interference effects harder to observe with polychromatic light? Describe how could you create a monochromatic light source using polychromatic rays from the sun?

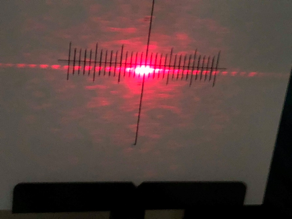
Monochromatic lights like a laser will emit light of one specific wavelength. Polychromatic light emits light at different wavelengths such as a lightbulb. It is hard to observe the interference effects with polychromatic light because the waves must originate from a coherent source for interference patterns to occur. Using a prism, you can aim the rays of the sun at it and a spectrum of colors will come out of it.

1. Derive the formula that relates the wavelength of the light to the interference pattern fringe spacing. Show your work with algebra and geometry. Include a picture of your interference pattern as it appears on the screen. Provide an estimate using the measurements you obtained for the wavelength of the laser light.

L = 86 cm, screen = 3 cm, d = 0.25 mm

              Δr = nƛ=Δr/d =sinθ =Y/L

Therefore, the wavelength is 569.76 nm, it falls under the range of the color yellow.



Conclusion:

We were able to observe the effects of the nature of lights. For the first experiment, we used an incandescent light source to shine light through a slit and onto a screen. As we moved the light beam towards single slits of different widths, the light intensity increased. As the light beam was moved away from single slits, the light intensity decreased. This meant that the distance between the light source and the slit affected the intensity every time. For the second experiment, we used a monochromatic light to do the same process but this time, double slits were also used. This time the intensity did work the same way as the incandescent light source but, the light projected on the screen was a horizontal line of a light with gaps in between. The gaps happened because the laser beam was going through a double slit and had waves interfering with each other. In the end, we found the wavelength of this laser to be 569.76 nm which indicated that it was a red laser.  Our calculation was clearly not correct because the wavelength of red is from 700 nm to 635 nm.  The wavelength of 569.76 nm is listed under yellow. Possible reasons for wavelength value being so low is maybe due to our recorded measurement of y which was the length of the gap. We attempted several tries and it became difficult because the gap was very small. Correct measurements are key for accurate results and so we must pay better attention next time.