Reversibility and Dispersion

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**Abstract**

In examining properties of light between mediums in classical optics, this experiment demonstrates reversibility of refraction though an acrylic medium by measuring the index of refraction for acrylic, as well as the dispersion of light through a cylindrical lens. This optics experiment consists of two parts: the reversibility experiment, and the dispersion experiment.

**Introduction**

The reversibility experiment was concerned with demonstrating optical reversibility by measuring the index of refraction for acrylic. To measure the index of fraction for a material, *Snell’s Law* is a formula which relates the angle of light incident on a surface with the angle of refracted light in the surface with indices of refraction of the surfaces. The formula for Snell’s Law is , where and are the indices of refraction, is the angle of incidence, and is the angle of refraction. The Dispersion Experiment was concerned with observing the dispersion of light—where light is separated from a white beam into multiple colors—and the indices of refraction for observed blue and red light. Once again, Snell’s Law was utilized.

To obtain and measure these values, a half-circular lens—with both a curved side and a flat side—was placed in the center of a circular rotating table. The table was rotated so that beams of light were indecent on the lens at specific angles. This experiment also assumes the index of refraction for air to be 1.

**Data & Analysis**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Trial 1: Ray Incident on Flat Surface | | |  | Trial 2: Ray Incident on Curved Surface | | |
| Angle of Incidence  () | Observed Angle of Refraction  () | Calculated Index of Refraction for acrylic () |  | Angle of Incidence  () | Observed Angle of Refraction  () | Calculated Index of Refraction for acrylic () |
| 0 o | 0.0 o | - |  | 0.0 o | 0.0 o | - |
| 10 o | 8.0 o | 1.2477 |  | 8.0 o | 11.0 o | 1.3710 |
| 20 o | 13.5 o | 1.4651 |  | 13.5 o | 20.0 o | 1.4651 |
| 30 o | 20.0 o | 1.4619 |  | 20.0 o | 30.0 o | 1.4619 |
| 40 o | 26.0 o | 1.4663 |  | 26.0 o | 40.0 o | 1.4663 |
| 50 o | 31.5 o | 1.4661 |  | 31.5 o | 50.0 o | 1.4661 |
| 60 o | 36.5 o | 1.4559 |  | 36.5 o | 61.0 o | 1.4704 |
| 70 o | 40.0 o | 1.4619 |  | 40.0 o | 70.0 o | 1.4619 |
| 80 o | 42.0 o | 1.4718 |  | 42.0 o | 80.0 o | 1.4718 |

Table 1.1

In looking at the Reversibility Experiment, trial one expresses the ray incident on the flat surface, and trial two expresses the ray incident on the curved surface. The outcomes of these two trials gives vary similar answers in both the angles and the index of refraction of acrylic found by using the Snell’s formula adjusted to solve for: . Below is the average for trial 1 and 2:

|  |  |
| --- | --- |
| Trail 1 | 1.4371 |
| Trail 2 | 1.4543 |

Table 1.2

By experimentally determine that both of the values are approximately equal, the reversibility of classical optics was thus demonstrated. ∎

Finally, in looking at the dispersion of light through the acrylic medium, the minimum angle at which dispersion occurred was found, and the angle at which the dispersion was at a maximum was found: these values were determined to be 60o and 80o, respectively. The white beam was broken to a rainbow of colors, approximately in the order of red, orange, yellow, green, and then blue.

Even though the index of refraction for a material is expressed as constant, different wavelengths of light refract at slightly different angles. The indices of refraction for acrylic, measured from the red beam and the blue beam, are recorded below.

|  |  |
| --- | --- |
| Index of Refraction for acrylic – red() | 1.5027 |
| Index of Refraction for acrylic – blue () | 1.5321 |

Table 2.1

**Conclusion**

In looking at the Reversibility Experiment, the reversibility of classical optics was demonstrated in trial one and two; that light rays incident on either side of a half-circular lens results in the same index of refraction for that medium.

In looking at the Dispersion Experiment, the color separation of light was first noticed at the incident angle of 60o, and can be seen up to an angle of approximately 80o. For the angles beyond these, the colors were totally internally reflected. Between these two angles, the colors of red, orange, yellow, green and blue were identified in the refracted ray.