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| **Error Propagation – Snell’s Law** | | |
|  |  | Snell’s Law |
|  |  |  |
|  |  | Solve for and assume is 1.0 |
|  |  |  |
|  |  | Take partial derivatives for and |
|  |  |  |
|  |  | Definition for absolute error. |
|  |  |  |
|  |  | Definition for relative error. |
|  |  |  |
|  |  | Substitute |
|  |  |  |
|  |  | Simplify |
|  |  |  |
| **NOTE 1.1**  For each experiment, use the smallest measured angle data set to estimate maximum error.  Take the absolute error for both and to be the maximum angle difference between each congruent angle set, that is, to and to for each trial. For example, the maximum difference of to for plastic was on trial 2, where  **Plastic:**  **Water:** | | |
|  |  |  |
| **Plastic:** |  |  |
|  | | |
|  |  |  |
| **Water:** |  |  |
|  | | |

|  |  |  |
| --- | --- | --- |
| **Percent Discrepancies** | | |
|  |  | Definition of percent discrepancy. |
|  |  |  |
|  |  | Plastic |
|  |  | Water |

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**Discussion of Results / Conclusion**

The experiments yielded favorable results consistent with the theoretical indices of refraction of plastic (1.49) and water (1.33). As no theoretical index of refraction for the plastic cube was given, a value from the National Physical Laboratory (www.npl.co.uk) was used. The index of refraction of plastic was experimentally found to be , and water . The percent discrepancies of these results are **8%** and **1%** respectively, which are both well-within the allotted margins of error.

The margins of error were found using an error propagation technique. The absolute errors for each angle, and , were analyzed separately for each experiment, and determined to be the maximum differences between measured congruent angles for all three trials (see **Note 1.1**). This generous margin of error helps account for the major sources of error, primarily that of human observation. Placing pins on both sides of a cube while looking through the cube such that the pins lined-up with human visual perception was undoubtedly the most erroneous portion of the experiment. The water cube proved to be even more erroneous due to the larger distance between pens on each side of the cube, thus increasing the observational fuzziness related to human nearsighted versus farsighted focus. Interestingly, the overall discrepancy was greater for the plastic than it was for the water, even though the water had a greater margin of error. It’s worth noting that the theoretical value for plastic may be incorrect as the exact type of plastic, which is unknown, can significantly change the index of refraction.

The experiment could have been significantly improved by using a laser to penetrate through the cube in place of human observation of ambient light passing through the cube. This would lead to a much more accurate ray trace, and in turn, very precise angles.