Intensity of transmitted light

Olympic College Phys 256

# Overview

We often treat light as if it is either reflected *or* refracted when it encounters an interface. But we know this is not the case–have you ever looked through a window but also seen your reflection at the same time? While most light is *transmitted* through the window, some is reflected back at you.

In this lab, you will use a simulation to investigate the intensity of transmitted light. In addition to learning about some of the physics of light, this lab will also develop a couple of experimental skills:

1. Determining a mathematical relationship between two variables when you don’t have any idea of what that will be going into the experiment.

We frequently use graphical analysis to determine relationships between variables, but in all of your physics labs so far, you’ve had some idea of what what would look like before you got started (or at least the information was close at hand, even if not given directly). In this lab, you won’t have anything to go off of except the data you collect.

1. Presenting graphs for a report.

Again, you’ve made lots of graphs for physics class, but you’ve never *really* had to consider the presentation of the graphs. Generally you’ve had one data set per graph, and used multiple graphs to present multiple data sets. For this lab, the direct comparison between data sets is important, so you’ll need to consider the visual elements the graph: using differently shaped data points for different data sets; making good use of color; including a legend; and so on.

## Simulation

You will use the [Bending Light](https://phet.colorado.edu/en/simulation/bending-light) simulation (<https://phet.colorado.edu/en/simulation/bending-light>). It is coded with html5, so it will run in your web browser. Run the simulation, and select the *More Tools* tile.

In this simulation, you have a laser that shines from one medium to another. You can control the index of refraction of each medium. In the panel on the left side of the screen is a sort of toolbox; click on the intensity sensor and drag it out. When light passes through round sensor, it reads out the intensity as a percentage of the intensity of light leaving the laser pointer. The intensity of transmitted light is called *transmittance*, and can be expressed as either a percentage or a decimal.

## Analysis

For this lab, you will be taking data and determining lines of best fit. You should be using Logger Pro for the data analysis; Excel does not give you adequate choices.

When determining lines of best fit, *do not* make your decision based solely on things like correlation and RMSE values. These can be useful, but it is easy to get carried away. For example, you can easily have a very high correlation value for high-order polynomials, but these are rarely a good representation of what is going on. You also want to consider simplicity–for two lines that both fit the data fairly well, choose the one with the simpler equation.

For this lab, do not worry about error bars. If you’re using the simulation correctly, the error bars will be negligibly small.

# Tasks

Your task is to determine a mathematical relationship between transmittance and the index of refraction the light is being transmitted into. For simplicity, take the first medium (the one the laser starts in) to be air (n = 1.000). Select an angle of incidence, and take data on transmittance vs. index of refraction. Then, select a different angle of incidence and repeat. Continue this process for several[[1]](#footnote-2) incident angles, spread out across the whole range of 0° to 90°.

Plot all data on the *same* graph. Include a legend; in Logger Pro this can be found under the Analyze menu.

Determine a line of best fit for each set of data. We’re looking to get at a general expression, so you need to find a type of function that works well for *all* sets of data. (For example, don’t use an exponential function for one data set, and a cosine for another.)

# Report

You will write a full lab report for this lab. Your main result is what kind of function you determined best represents the relationship between transmittance and index of refraction. So, you need to include what kind of equation you determined is best in the abstract, discussion, and conclusion.

Your discussion should focus on how you determined what kind of function to use, and a start at determining what the different fit parameters (e.g. coefficients) represent, and how they relate to your system.

For both parts of the analysis (what kind of function, and what the parameters represent), I’ll be evaluating you more on process and consistency than on getting the “right” answer. Just make sure your conclusions are reasonable, and consistent with each other and the data.

1. The tendency many people have is to work in threes: take three data points, or three trials, or three sets of data. *This is insufficient to draw strong conclusions.* The “right” number use use depends on what you’re doing, but three is *never* enough once you get past high school science. For this lab, try using five different incident angles as a starting point. You may need to use more. [↑](#footnote-ref-2)