**Ray Optics**

Use the ray optics kit to study how light reflects off a shiny surface, and how it refracts when entering a transparent material.

Online resources:

<http://www.walter-fendt.de/ph14e/>

<https://phet.colorado.edu/sims/html/bending-light/latest/bending-light_en.html>

Equipment:

Plastic trapezoid

Plastic mirror

Light sources

Paper

Protractor

Procedure:

Part I. Reflection

Take a plane mirror.

Place the mirror in front of the ray source and observe the reflection.

Investigate whether the angle of reflection equals the angle of incidence.

This is a very simple law, and is easily verified.

Verify for 3 different angles of incidence.

Enter the results of your measurements in the table.

Do your results depend on the color of the light?

|  |  |  |
| --- | --- | --- |
| Measurement | Angle of incidence | Angle of reflection |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |

Part II. Refraction

Snell’s Law,

n1 sin1 = n2 sin2

What is the meaning of n1, n2, 1 and 2 ?

This law comes from the light speed slowing down in matter. Analogy in the picture to the right.

Take a trapezoidal piece of plastic and let the light ray shine through it as shown in the figure below.

Now outline the trapezoid and trace the light ray.

Place a piece of white paper under the apparatus, and use a pencil to indicate points on the path of the ray.

For instance, make a dot where the ray leaves the light source, where it hits the plastic, where it leaves the plastic, and where it is about an inch away from the plastic.

Then connect the dots to show the lines followed by the light ray.

Now measure the angles, using a protractor, and use Snell’s Law to find the index of refraction for this plastic material.

Note that you have refraction both when the light enters the plastic, and when it leaves...so you could apply Snell’s Law twice.

Ideally, you should get the same result in each case.

Do only one today.

[You may find that the two values that you got for n are somewhat different because of the uncertainty in accurately measuring the angles. This will be especially true if your angles are small.]

Does the value of n depend on the color (wavelength) of the light?

[It should, but I failed to notice a difference]

Part III. Total Internal Reflection

Rotate the trapezoid slowly and watch as the refracted rays get closer and closer to the outer surface of the trapezoid.

At the angle where the refracted rays disappear, and only reflection takes place at the inner face, stop rotating the trapezoid.

Measure the light rays as you did in the previous section and see if you can calculate the index of refraction from this information.



Total internal reflection comes straight from Snell’s Law:

n1 sin1 = n2 sin2

with the exit angle 2 now being 90 deg.

sin(90o) = 1 and 1 is the incoming angle, now called critical angle c.

That makes

sinc = n2 / n1

n1 is the index of refraction of that trapezoid and n2 is the index of refraction of air, which is 1.

Application: Fiber optics

