Refraction Coursework

Aim: To find out whether there is a relationship between the incidence ray and the reflected ray when it passes through a different medium e.g. glass, water e.t.c.

Refraction Of Light

Refraction is a physical process of the deviation of the light rays bending as they enter another medium of an altered density. When the light rays hit the Perspex block, they bend in the direction of the normal. This is due to the light rays slowing down as they enter another medium. Think of it as a truck that is on a superior road surface approaching marshy land at an angle. The wheels of the truck will make contact with the marshland at different stages, when the first wheel enters the marshland, it slows down. Meanwhile the other wheel that is still on the tarmac will be going at its original speed, therefore the whole truck turns into the marshland. This is also true with the light rays also. Looking at it from a more scientific view, white light rays are made up of seven different waves they are:

Red
Orange
Yellow
Green
Blue
Indigo
Violet

These are all the colours of the spectrum and all have different wavelengths red having the longest wavelength and violet having the shortest wavelength. The red waves get bent the least whereas the violet rays get bent the most. We can calculate the refraction of light using the formula sin I / sin R. average the results and we can get a constant called the absolute refractive index. I found out that you could use refraction to test the density of various jewels to see whether they are original.

Factors that could affect my results

The factors that could alter my results are:

The slit: if the slit isn't thin enough, then we could get the light rays at a slight angle from the pencil line on the diagram.

Cracks in the Perspex: if there are any cracks or broken pieces of Perspex then we know that the light inst going to behave correctly, the normal might be slightly altered.

If the Perspex block does not line up with the line drawn on the graph: this could result in the normal being at an angle and therefore even if our placing of the incident ray is correct, it will still give us odd results

Prediction

From preliminary tests we know that as light travels from air into Perspex, it bends towards the normal line so the angle of refraction is always smaller that the angle of incidence. From research it can be found out that the relationship between the two angles is sin I / sin R is called the refractive index. By plotting a graph of sin I against sin R, the gradient of the graph should give the refractive index of glass.

Results

Sin results

Perspex 1

Incident ray (degrees)	Reflected ray (degrees)
10.00	5.50
20.00	12.50
30.00	19.00
40.00	24.50
50.00	28.00

Sin I	Sin R
0.17	0.10
0.34	0.22
0.50	0.33
0.64	0.41
0.77	0.47

Perspex 2

Incident ray (degrees)	Reflected ray (degrees)
10.00	5.50
20.00	12.50
30.00	18.00
40.00	24.50
50.00	30.50

Sin I	Sin R
0.17	0.10
0.34	0.22
0.50	0.31
0.64	0.41
0.77	0.51

Water 1

Incident ray (degrees)	Reflected ray (degrees)
10.00	7.00
20.00	15.00
30.00	22.00
40.00	27.50
50.00	35.00

Sin I	Sin R
0.17	0.12
0.34	0.25
0.50	0.37
0.64	0.46
0.77	0.57

Water 2

Incident ray (degrees)	Reflected ray (degrees)
10.00	7.50
20.00	14.50
30.00	22.00
40.00	28.50
50.00	35.00

Sin I	Sin R
0.17	0.13
0.34	0.25
0.50	0.37
0.64	0.48
0.77	0.57

Average results

Average sin for Perspex

Sin I	Sin r
0.17	0.10
0.34	0.22
0.50	0.32
0.64	0.41
0.77	0.49

Average Sin for Water

Sin I	Sin R
0.17	0.13
0.34	0.25
0.50	0.37
0.64	0.47
0.77	0.57

Safety

For safety we made sure:

We all wore goggles.
Kept water and all liquids away from the power pack.
Do not eat or drink in the lab.
Make sure that the power switch is turned off before plugging in the plug for the power pack.

Analysis

I have found out that light rays deviate from the original path after making contact with another medium. The light waves bend in towards the normal when entering the Perspex or glass and bend outward from the normal. Light travels at 300000 km/s in air (or in a vacuum) but once it hits the Perspex or the water the light waves will slow down. For Perspex it will slow down to 200000km/s. The

more light slowed down when it enters a medium from air, the greater the refractive index of a medium, and the more it is bent.
From my experiment, I noticed that you could not see the light refracting inside the Perspex block, instead all you could see was the emergent ray. Another observation I noticed was that the closer you put the ray box to the Perspex block, the stronger the emerging ray will be, we used this to our advantage to get accurate results, we put the ray box 4 cm's from the Perspex block at all the angles. Also I noticed that the emergent ray was parallel to the incident ray. A ray travelling along the normal is not refracted, it will still slow down like the light hitting the medium at an angle but will not deviate from its path.

From my graph of average results we can see that there is indeed a difference in the speed of the light waves, as the Perspex is a denser medium for the light to travel through, this is represented on my graph of average sin. The gradient of the Perspex is steeper that the gradient of the water, this shows us that the light waves will have been slowed down a lot more that those travelling through the water. This theory is also evident from my ray diagrams, at 10^{o} in water the refracted ray was 5.5^{o}, whereas in the water the refracted ray with the incident ray being 100 the refracted ray was 7^{0}. This evidence can also be seen from my raw results. To find out how accurate my experiment was, I went on to the Internet and found out about the refractive index of different materials. The refractive index according to the website that I looked at which is http://www.is.kiruna.se/~cjo/d2i/REFRACTION.INDEX3.html, the refractive index for glass is 1.5, in my experiment we got 1.56, a result which is two hundredths off. I also found out the refractive index for water. The refractive index according to the website I looked at (the same one as above) shows me that the refractive index for water is 1.33. From my calculations I worked my absolute refractive index for water to be 1.30. The result shown on the website is taken at a temperature of 20^{0}C. As the molecules of water expand as the temperature of the water gets increased. Therefore the temperature on the day that we did the experiment must not have been at 20 degrees. Another possibility is that we did the experiment slightly inaccurately. If that is the case, I think that the only place that we could have made an improvement on was the slit for the light to pass through. It could have been much narrower to avoid getting the placing of the beam of light at an angle to the drawn guides.

Conclusion

From my prediction I said that light bends in towards the normal. I have proven my prediction correct by my ray diagrams alone, if you look on the angle of incidence of lets say 10 degrees, the refracted angle will be 5.5 degrees.

Evaluation

The experiment went well, although I conducted the experiment as accurately as we could I was not happy about only one result, and that is the one that was the Perspex $50^{0,}$ the two experiments I did for reliability did not quite get be the reliability that I wanted for that particular angle, so If I was to improve I would have to do the experiment a third time to make absolutely sure that all my results are about the same as each other. Apart from that all the results in my graph were close to the line of best fit, so the accuracy of our experiment was good. For further accuracy of our experiment, I would get the thinnest possible slit for the ray box to make sure the ray isn't wide so we don't get the ray of incidence 1 or 2 degrees off which could led to odd results. We did each experiment twice, and got fairly similar results, so I am positive that the results that I got were reliable(apart from the 50^{o} Perspex). To extend my enquiry further I would test some more materials.