Refraction of light

Introduction:

Why the stick seems to be broken when it has been put in the water?

When light passes through two different mediums, it refract.

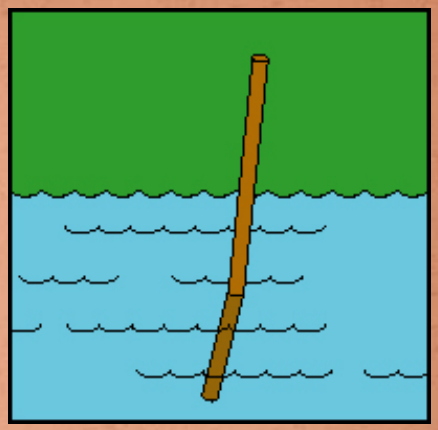
Does the light refract in the same ratio?

Of course not, because the speed of the light differs from medium to another

The **refractive index** is the ratio of the velocity of light in a vacuum to that in a medium

To measure the refractive index, we apply

$$n = \frac{c}{v} \quad , n = \frac{speed\ of\ light\ in\ vacuum}{speed\ of\ light\ in\ the\ medium}$$



Speed of light in the vacuum = 300 000 000 ms^{-1}

Speed of light in the Perspex = 200 000 000 ms^{-1}

So, the refractive index of Perspex using the equation :

$$n = \frac{speed\ of\ light\ in\ vacuum}{speed\ of\ light\ in\ the\ Perspex}$$

$$n = \frac{300000000}{200000000}$$

$$n = 1.5$$

It is very difficult to measure the speed of light in the Perspex.

Is there any other way to find out the refractive index of Perspex regardless the speed of light ?

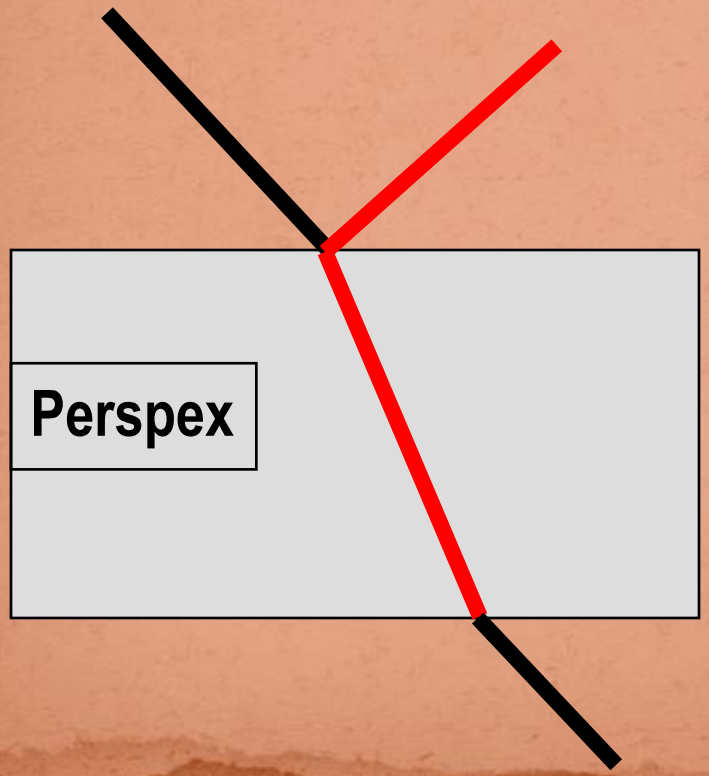
From the figure 1.0 we can find that

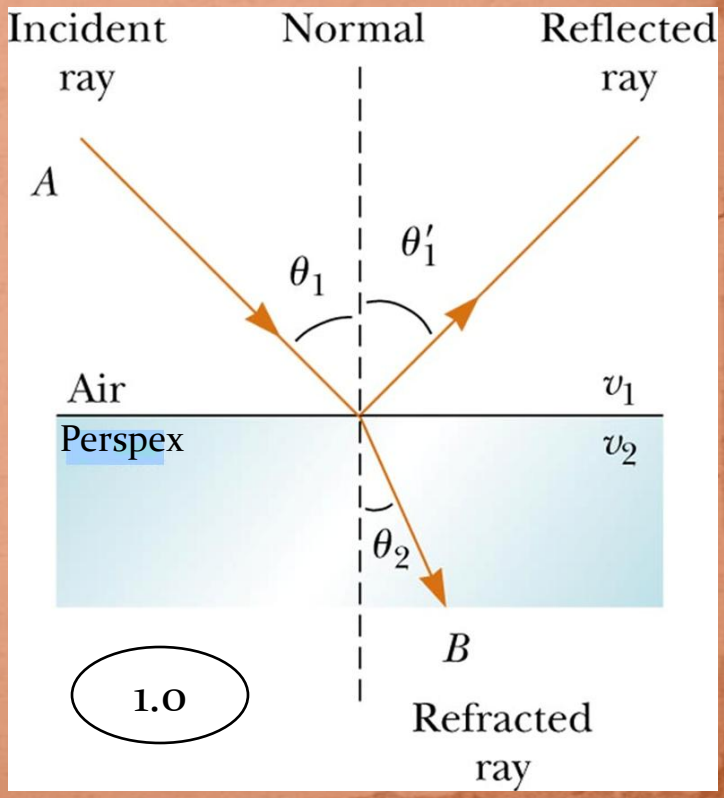
$$n = \frac{v_1}{v_2}$$

Can we make the equation

$$n = \frac{\theta_1}{\theta_2} \; or \; n = \frac{\theta_i}{\theta_r} \; , n = \frac{sin\theta_i}{sin\theta_r}$$

where θ_i is the incident ray and θ_r is the refracted ray





Aim:

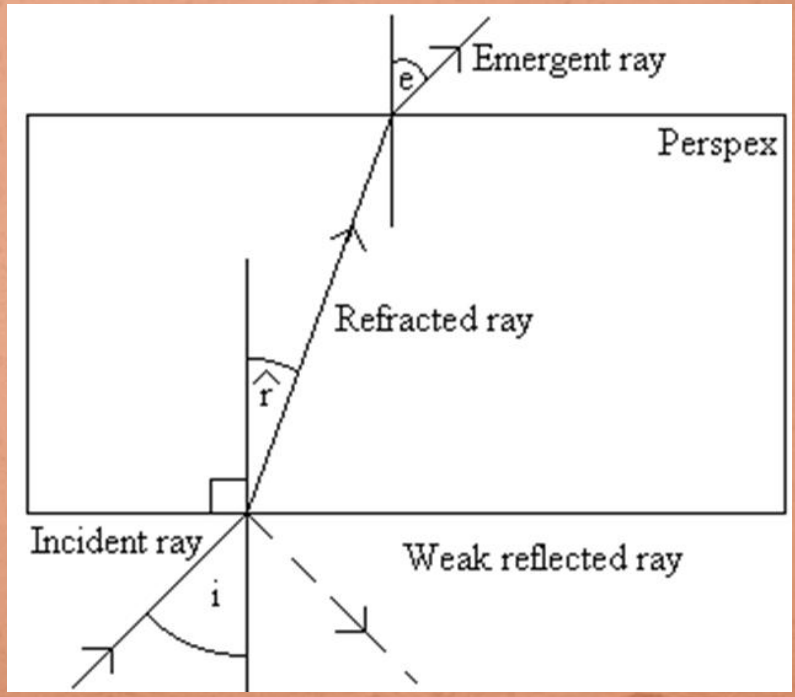
•To investigate the relationship between the angles of incidence and refraction as light travels into a rectangular Perspex block.

•To verify experimentally the formula: refractive index $n = \frac{sin\theta_i}{sin\theta_r}$

Method:

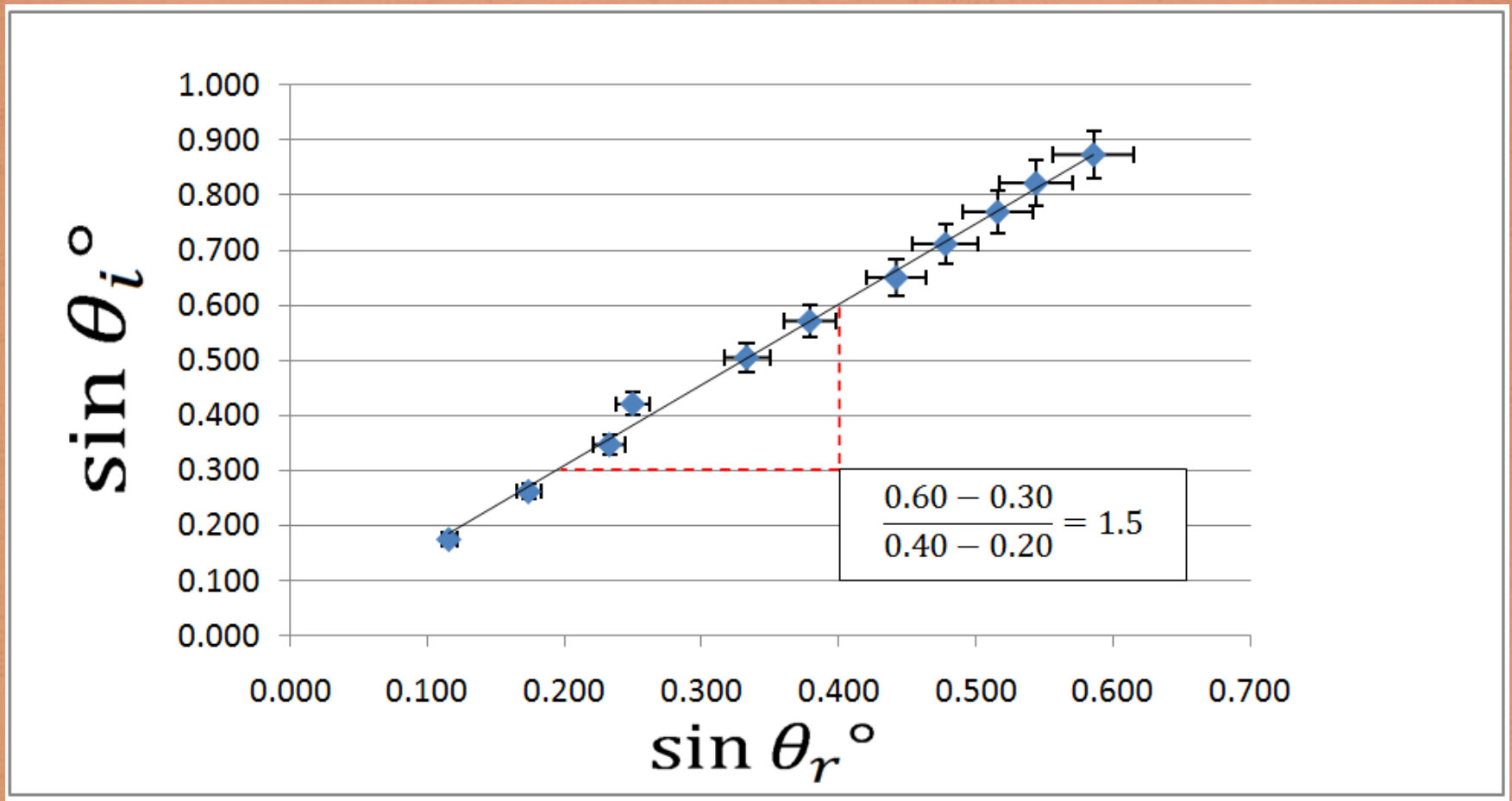
In order to examine the formula we have to:

1. Place the rectangular Perspex block on a sheet of white paper.
2. Draw around the block (incase it gets disturbed)
3. Shine a single, thin ray of light from a ray box, incident to one long face of block.
4. Mark the incident ray entering the block and the emergent ray existing the block.
5. Measure the angle of incidence (i) and the corresponding angle of refraction(r)
6. Vary the angle of incidence so that 8 different pairs of results can be collected.



1.1. Results for the Refractive index of Perspex experiment

Angle of incidence, $\theta_i° \pm 0.05°$	Angle of refraction, $\theta_r° \pm 0.05°$	$sin\ \theta_i°$	$sin\ \theta_r°$	$\frac{sin\ \theta_i°}{sin\ \theta_r°}$
10.1°	6.65°	0.175	0.116	1.51
15.2°	10.04°	0.262	0.174	1.50
20.3°	13.46°	0.347	0.233	1.49
*24.9°	15.25°	0.421	0.263	1.60
30.3°	20.13°	0.505	0.333	1.52
34.8°	22.29°	0.571	0.379	1.51
40.5°	26.23°	0.650	0.442	1.47
45.3°	28.54°	0.711	0.478	1.49
50.3°	31.09°	0.769	0.516	1.49
55.2°	33.97°	0.821	0.559	1.47
60.8°	36.37°	0.873	0.593	1.47
The mean value of the refractive index is				1.49 ± 0.03



1.2. The refractive index of Perspex

When doing the experiment, if you keep on moving the source of light, in a certain angle you will find that the refracted ray disappeared.

In this stage we have to introduce two things :

1. Critical angle where the refracted ray in a position perpendicular to the normal

2. Total internal reflection where all the light is reflected and there is no refraction (the incident ray is grater than the critical angle).

From different resources, it's mentioned that there is another way to find out the refractive index of the substances using the critical angle.

The formula: $n = \frac{1}{sin\theta_C}$, where θ_c is the critical angle

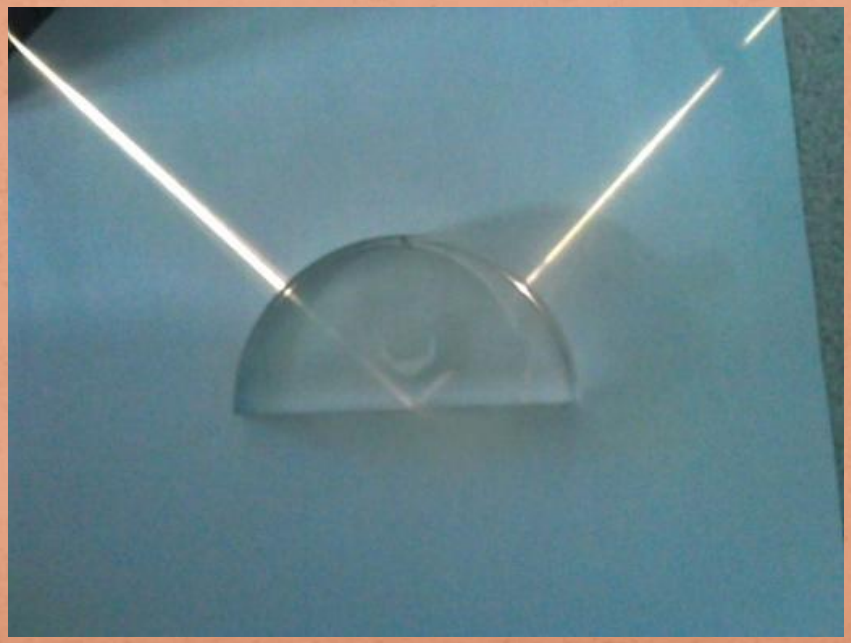
Aim:

•To investigate total internal reflection and the "critical angle", θ_c, of a refractive substance.

•To verify experimentally the formula: refractive index, $n = \frac{1}{sin\theta_C}$

Method

1. Place the semi-circular Perspex block on a sheet of white paper.
2. Draw around the block (incase it gets disturbed)
3. Shine a single, thin ray of light from a ray box, incident to curved face of the block, pointing at the center of the straight face.
4. Mark the incident ray entering the block and the emergent ray existing the block.
5. Increase the angle of incidence (i) until the emergent ray is in aposition perpendicular to the normal
6. Measure angle (i) and the corresponding angle of reflection



Data collection (part B):

1.3. The critical angle in a semi-circular Perspex

$\theta_c° \pm 0.05°$	$sin\ \theta_c°$	$\frac{1}{\sin \theta_c°}$
42.24°	0.672	1.49
43.12°	0.684	1.46
42.50°	0.676	1.48
41.96°	0.669	1.50
42.12°	0.671	1.49

Conclusion:

• We can find the refractive index of a substance using three different laws:

$$n = \frac{c}{v} \quad \text{or} \quad n = \frac{sin\theta_i}{sin\theta_r} \quad \text{or} \quad n = \frac{1}{\sin \theta_C^{\circ}}$$

• The refractive index of Perspex is about 1.49

•The critical angle of Perspex is about 42

Thank you very much

Done by :
- Musab Naiem
- Muhammad Mashtuli
- Bader Dalol
- Yuba Kamal
-Hazza Hammad
-Al-Wakra independebnt Secondary School For Boys

The most used resources :
-Complete physics
- physics (IBID)
-Advanced physics