REFRACTION AND TOTAL INTERNAL REFLECTION WITH JELLY

Have you ever wondered why when you drink from a straw, the straw looks bent? This is because light is refracted when it hits the liquid before reflecting back to your eye. Why does this happen?

What You'll Need

- 2 medium-sized transparent containers
- 1 red or green light
- 1 protractor
- 1 packet of jelly
- Water
- Calculator

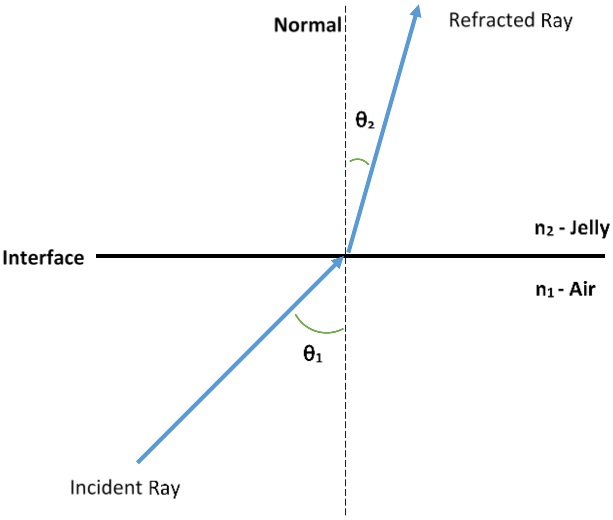
Refraction

When light passes through a more dense material, it slows down and causes the light to bend. This is refraction.

The measure of the change of speed of light passing through a material is called the refractive index. Light travelling through a medium with a higher refractive index will travel slower than one of a lower refractive index. The refractive index can be calculated using Snell's Law.

Snell's Law:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$



Refraction

In the equation above, n_1 is the refractive index of material 1 (air) and n_2 is the refractive index of material 2 (jelly).

The angle that the refracted ray makes with the normal to the surface is called the angle of refraction (θ_2). Similarly, angle of incidence (θ_1) is the angle between the incident ray and the surface normal.

Rearranging the Snell's Law, you can calculate the refractive index of the jelly (assuming n_1 is air with refractive index of 1.0):

$$n_2 = \frac{\sin \theta_1}{\sin \theta_2}$$

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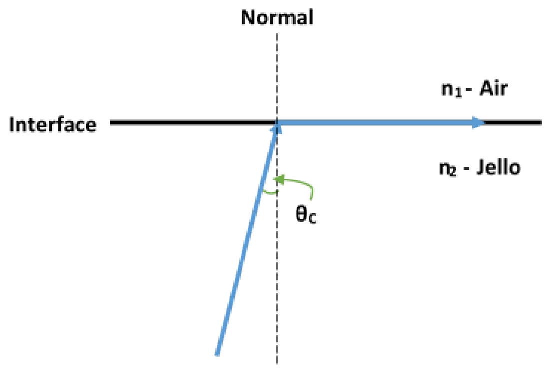
June 2017

Total Internal Reflection

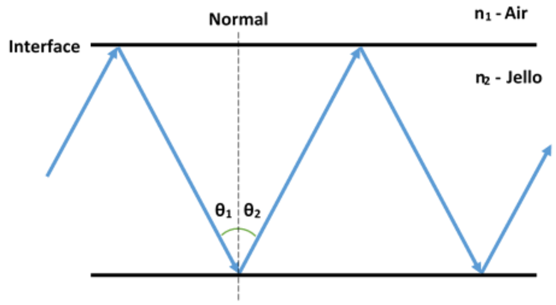
When light is travelling from a higher refractive index to lower refractive index medium, light is reflected off the interface if the angle of incidence is beyond a certain angle, called the critical angle. This phenomenon is called total internal reflection. All light will be reflected and no light is refracted.

At critical angle, the refracted ray travels at 90° to the surface normal. Using Snell's Law, the critical angle can be found:

$$\sin \theta_c = \frac{n_2}{n_1}$$



Critical Angle



Total Internal Reflection

Total Internal Reflection in Real Life: Optical Fibres

How do you get Internet access in your homes? Most likely fibre optic broadband.

Optical fibres are similar to wires but instead of transmitting data as electric signal, they are transmitted as pulses of light. Light is inserted at one end of the optical fibre and it will emerge from the other end. How this works is by total internal reflection. The optical fibres are made from glass that have low losses, and therefore they can be thousands of kilometres long - transmitting information from one side of the world to another.

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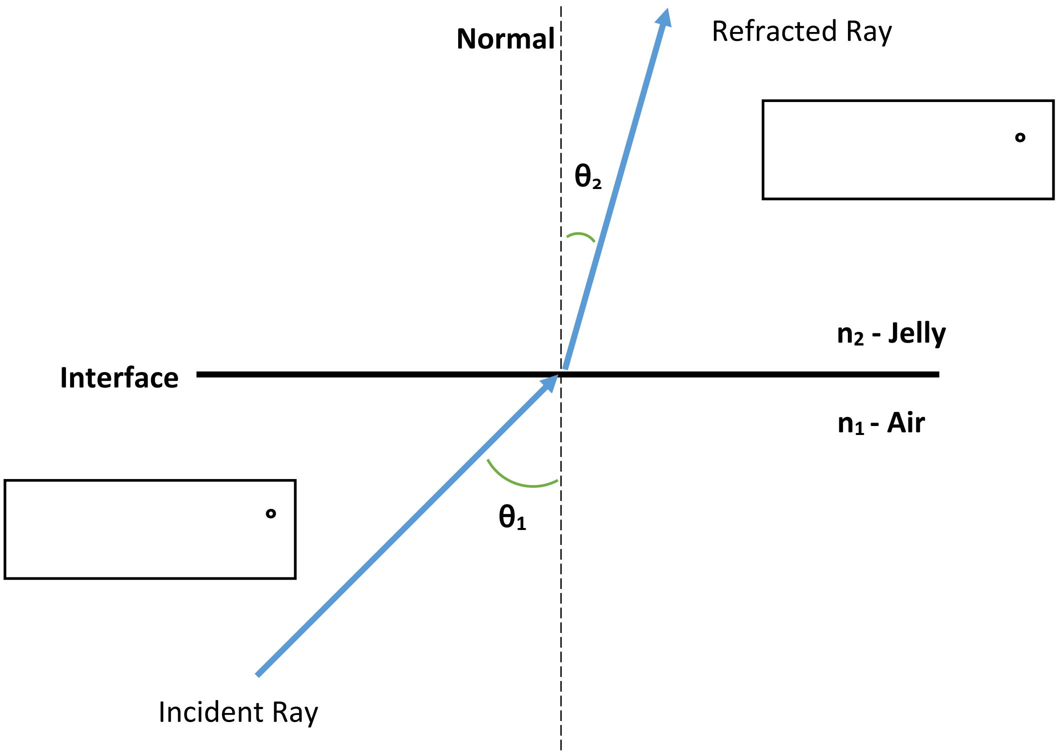
Worksheet

1. Place the edge of the jelly box on the centre line of the protractor slightly off-centred.

2. Shine the light, at an angle, into the side of the clear jelly. Make sure the light pass through the cross of the protractor.

3. Measure the angle of incidence and angle of refraction. Write the angles in the boxes.



4. Using Snell's law, calculate the refractive index of the clear jelly? (n_1 = 1)

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