Snell's Law , Refraction and Total Reflection

We are going to talk about light. Light is an electromagnetic phenomenon, and already in the 16th century, way before Maxwell, a lot of studies were done of the interaction of light with water and with glass.

A Dutchman, Snellius, who in the 17th century, found three rules that govern the relation between these three light beams. The first one is that **the incident light, the reflected light and refracted light** are in one plane. The second thing that he found, that the angle of reflection θ_3 is the same as the angle of incidence θ_1. And the third one, which is the most surprising one, which is called after him, which is called Snell's Law. If we go from air to water, then

$$\frac{\sin\theta_1}{\sin\theta_2} = 1.3$$

θ_2 is the angle of refraction. If you go from air to glass, the ratio is a little higher, it is like 1.5 or so. He introduce the idea of index of refraction, which is called n as in Nancy -- index of refraction. For vacuum, the index of refraction is 1. But it's very closely the same in air, we always treat it as 1 in air. And in water, the index of refraction is approximately 1.3, and in glass, depending upon what kind of glass you have, it's about 1.5. And so we can now amend Snell's Law.

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$

n_1 being the index of refraction of the medium where you are, your incident beam.n_2 being the index of refraction of the medium where you are travelling to.

And we are from water travelling to the air. There will be a point that the angle of refraction doesn't exist anymore, because the $\sin\theta$ must less or equal than 1. And all the light is now being reflected off the surface. And we call that **total reflection**. the critical angle is

$$\sin\theta_{cr} = \frac{n_2}{n_1} \quad (n_1 > n_2)$$

The most important practical application is fibre optics.

Newton had a interesting explanation for Snell's Law. Newton was the man of particles, and so his explanation came with particles. He says light are particles. And a Dutch scientist Huygens said the light are wave. The wave-particle idea of light has been a very long-standing issue in physics.