Investigate the Refraction of Light

AIm:
The goal of this investigation is to investigate Snell's Law and Total Internal Reflection

Part 1: Refraction and Snell's Law

Variables:

- Independent: Angle of incident ray
- Dependent: Angle of refracted ray
- Control:
  - Wavelength of light

Procedure:

- Leaving the wavelength at a set value, change the angle of incidence to **5°**
- In your table of results, record the incident angle and the refracted angle
- Change the incident angle at least 6 more times (use a wide and evenly spaced range) and record the new refracted angle
- Plot a graph of *sin Θi* against *sin Θr*
- Measure the gradient of the graph - how does it compare to your refractive indices?

Θ_i (°)	Θ_r (°)	sin Θ_i	sin Θ_r

Theory:

From GCSE, you will recall that Snell's Law was written as:

$$n = \frac{\sin i}{\sin r}$$

This is a special case where the refractive index of the incident medium is regarded as *n = 1* with light travelling from air into the second medium.

Note: Strictly speaking n=1 only applies to a vacuum but air is close enough to 1 (within 3 decimal places).

The full Snell's Law equation is better written as:

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

Or, re-arranged to:

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

When an equation has, *n* unqualified, then it is referring to the *ratio* of refractive indices across the boundary i.e. $\frac{n_2}{n_1}$

Extension:

Different boundaries: Choose a different second material from the drop down options - how does this affect the refracted angle?

Different wavelengths: Choose a different wavelength of light - which one refracts more? Why is this happening?

Part 2: Total Internal Reflection

Aim:

To investigate Total Internal Reflection and find the critical angle for different boundaries

Procedure:

- Use the dropdown menu to choose Top Material as Glass and Bottom Material as Air
- Leaving the wavelength at a fixed value, gradually increase the angle of incidence until there is no longer a propagating refracted ray and all of the light is being reflected back into the denser medium.
- What is happening? Why does it happen?

Theory:

Using Snell's Law, complete the table below to show what happens as the incident angle increases.

θ_1	**sin θ_1**	**sin θ_2**	**θ_2 (predicted)**	**What happens?**
30°				
40°				
41.2°				
60°				

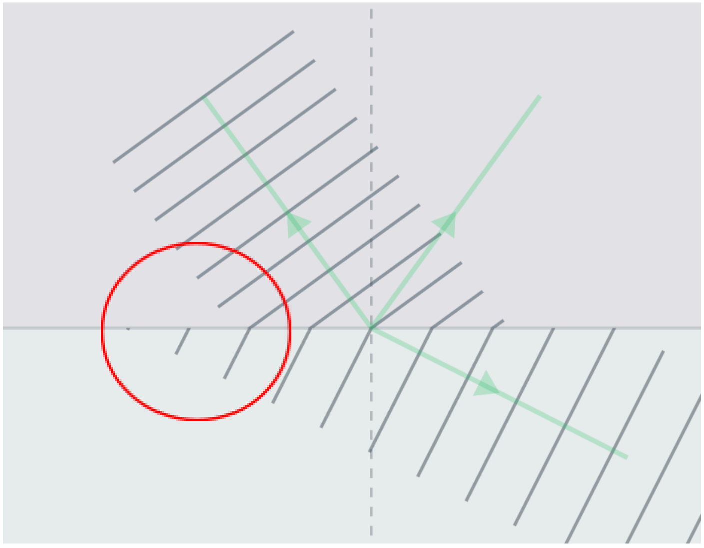
Why does this happen?

Wave model vs Ray model:

Toggle the view from ‘Ray’ to ‘Waves’

Bring the incident angle from smaller to bigger again until just before the critical angle.

What do you notice happening here?:



How can you use this model to explain why Total Internal Reflection must happen?