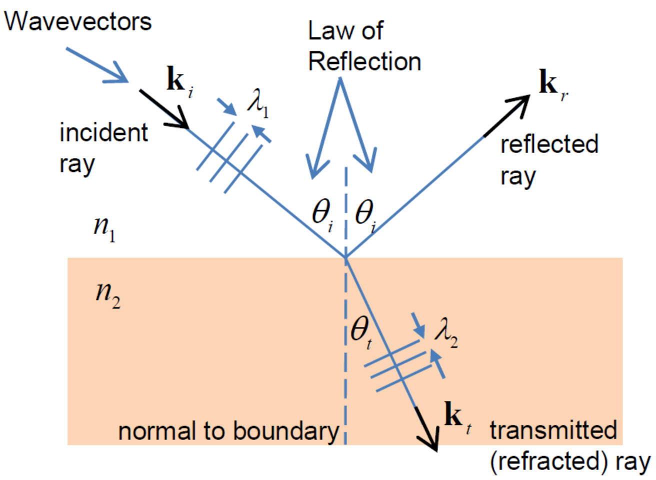
Snell's Law Practical

NAME: .... SET:...................... DATE:........................

Background Physics ideas

- Wave period = *time T* between wave crests
- Frequency (the number of waves per second, measured in Hertz, Hz). $f = 1/T$
- Wave speed equation: $c = f\lambda$
- For **reflection**, angle *of incidence = angle of reflection* (both from surface normal)
- *Refractive index* $n = \dfrac{\text{speed of light in a vaccum}}{\text{speed of light in a medium}}$ (n = 1 for vacuum, about 1.0 for air, about 1.5 for glass)
- For **refraction** of waves at a boundary between to mediums of different wave speeds we have Snell's Law: $\dfrac{\sin\theta_1}{c_1} = \dfrac{\sin\theta_2}{c_2}$, which for light (i.e. using refractive index) is $n_1 \sin\theta_1 = n_2 \sin\theta_2$.
  As for reflection, the angles are measured from the surface normal.
- The number of waves per second entering a boundary must equal the number of waves exiting i.e. frequency is conserved. Hence if wave speed changes, so does wavelength in the same proportion.



$$f = \frac{c}{\lambda} \quad \therefore \frac{c_1}{\lambda_1} = \frac{c_2}{\lambda_2}$$

$$c = 2.998 \times 10^8 \text{m/s}$$

All electromagnetic waves travel at the speed of light.

Scope of experiment

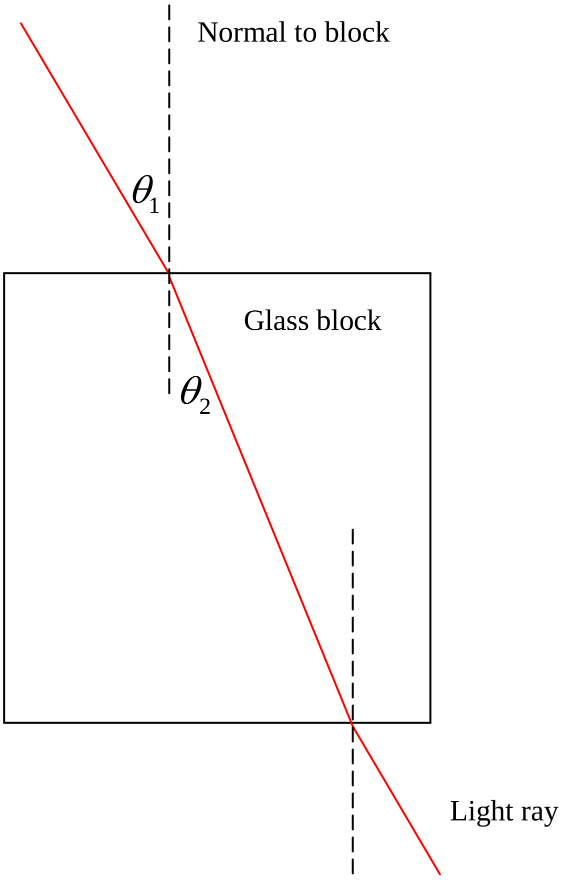
In this experiment you will shine light into a rectangular glass block and measure angle of incidence θ_1 and angle of refraction θ_2.

Snell's Law states $n_1 \sin\theta_1 = n_2 \sin\theta_2$, so if we plot a graph of $y = \sin\theta_2$ against $x = \sin\theta_1$:

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \Rightarrow n_1 x = n_2 y \quad \therefore y = \frac{n_1}{n_2} x$$

Since the region 1 is air, $n_1 \approx 1$. The refractive index for glass is about $n_2 \approx 1.5$. Hence we might *predict* a straight line graph of $y = \sin\theta_2$ against $x = \sin\theta_1$, with gradient about 1/1.5 = 2/3.

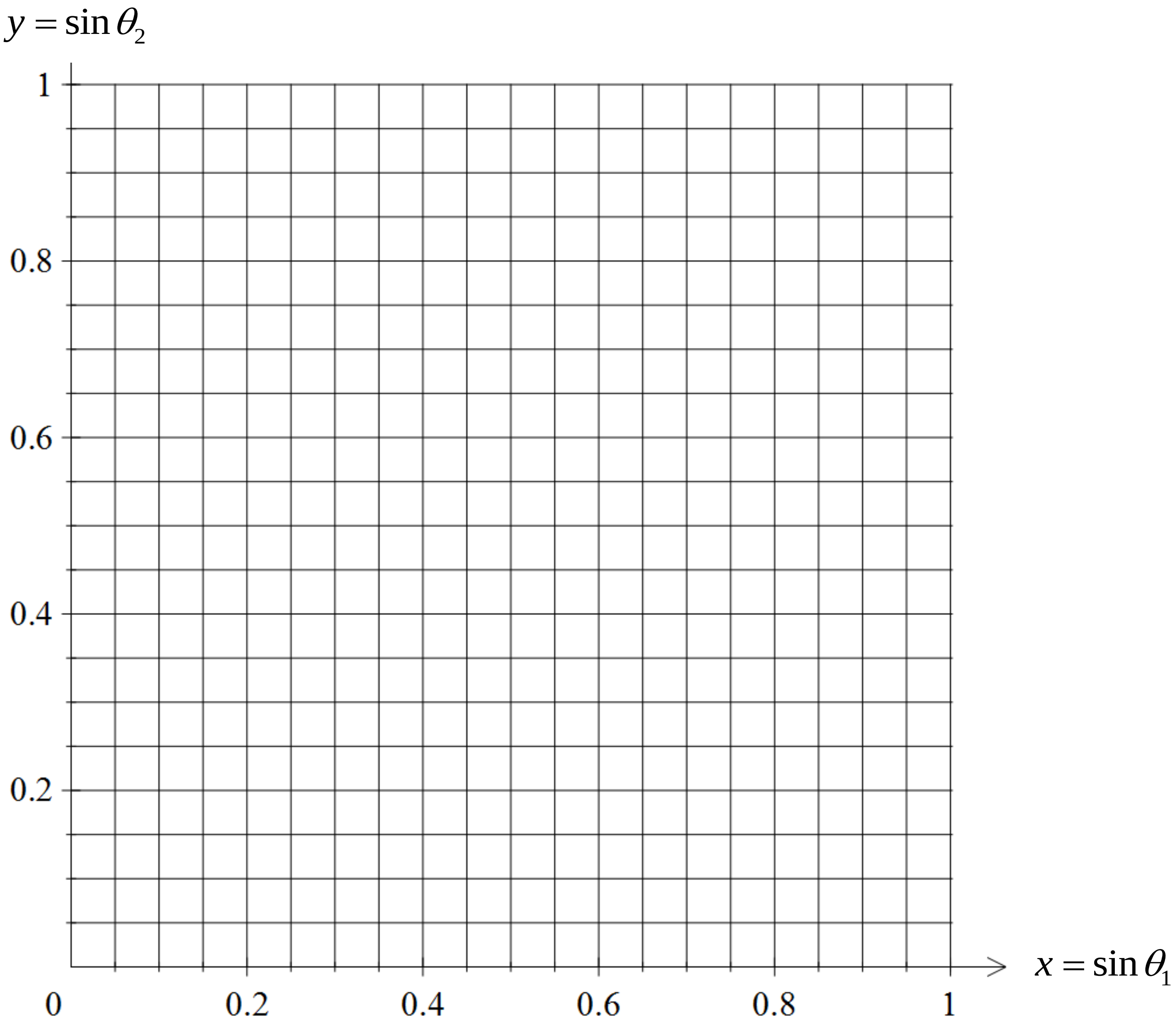
Experimental setup

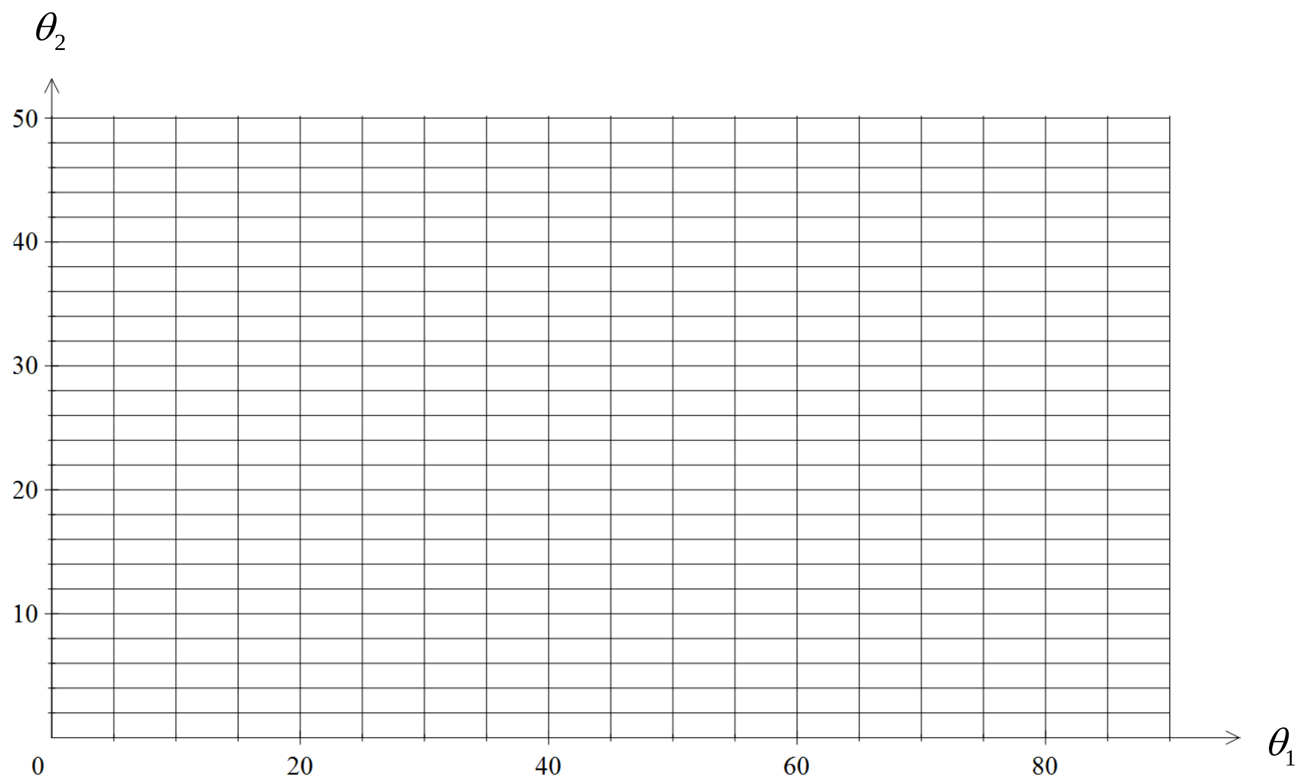


Make the following measurements carefully using a protractor and hence fill in the table below. You should be able to achieve precision to within a degree. *Don't fill in the last two MODEL columns yet!*

Angle of incidence θ_1 /deg	$\sin\theta_1$	Measured angle of refraction θ_2 /deg	$\sin\theta_2$	MODEL $\sin\theta_2 = \frac{n_1}{n_2}\sin\theta_1$	MODEL θ_2
5					
10					
15					
20					
25					
30					
35					
40					
50					
60					
70					
80					
85					

Plot the data *as you go* using the graph axis below





Draw a line of best fit through the graph of $y = \sin\theta_2$ against $x = \sin\theta_1$ and hence calculate the refractive index of glass, assuming that the refractive index of air is 1.00

Refractive index of glass is:

Hence fill in the columns labeled MODEL in the table, and plot lines on your graph. Hopefully there should be a strong agreement!

Comments /evaluation following experiment: