Question 16 **(18 marks)**

Light does not travel at the same speed in all materials. When travelling from air into a different material, light slows down and refracts. The amount of refraction is determined by the refractive index (n) of the material. It is calculated using the following equation:

$$n = \frac{c}{v}$$

where v is the speed of light in the material and c is the speed of light in a vacuum.

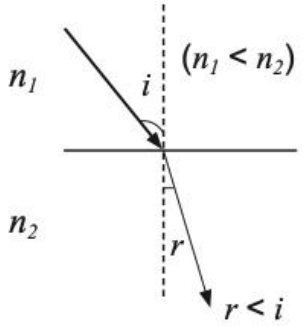
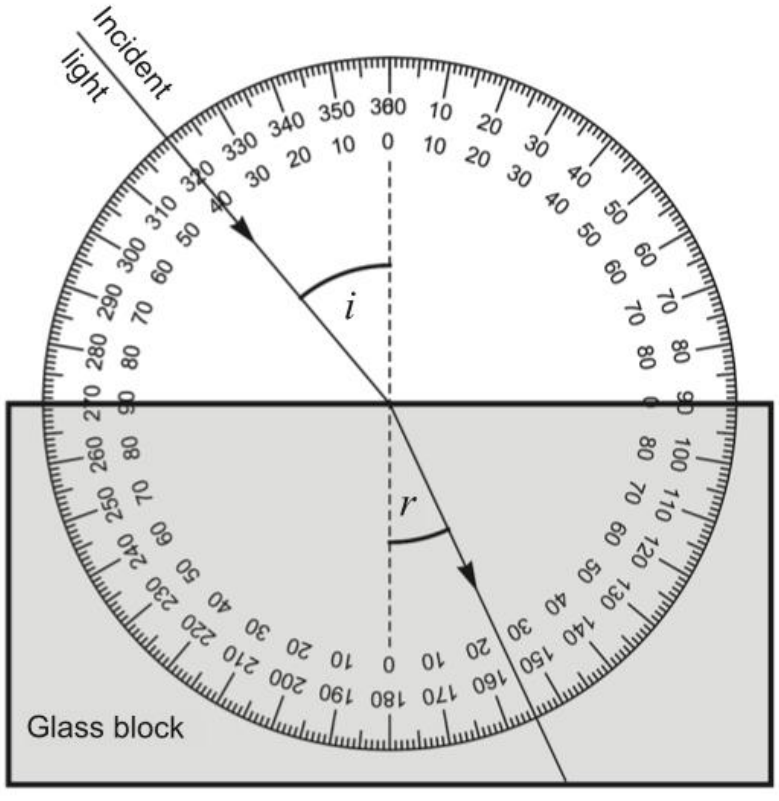


Figure 1: Light refracting at the boundary between two media.

From Figure 1, the following relationship can be demonstrated. This is known as Snell's Law.

$$n_1 \sin i = n_2 \sin r$$

A group of students try to determine the refractive index of a glass block by measuring the refraction of light incident on the block. Below is a schematic of their experiment showing the angle of incidence i and the angle of refraction r.

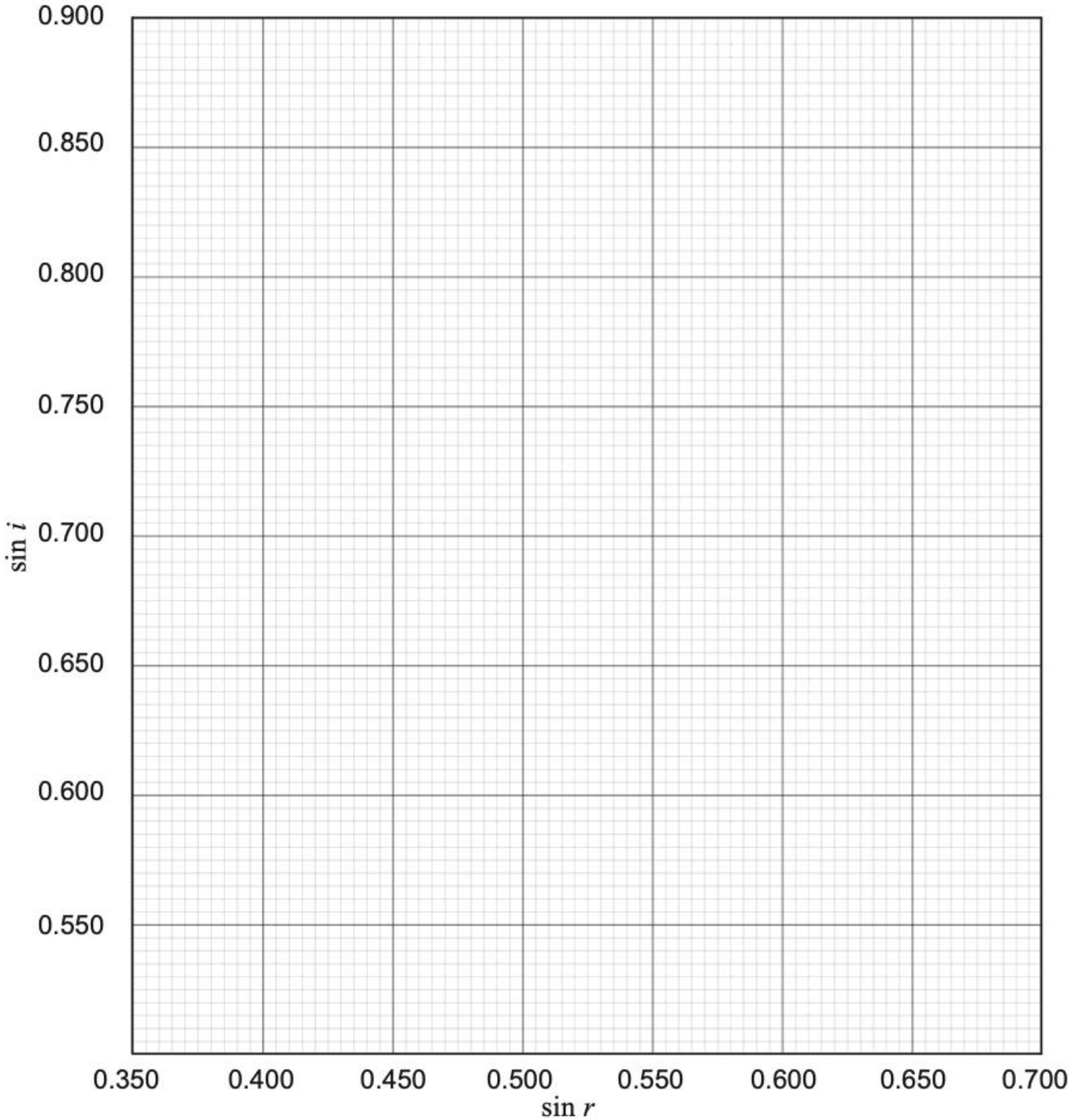


They varied the angle and found that white light produced a rainbow effect, which made measuring r very difficult. So they changed the light source to a monochromatic red light laser. They obtained the results in the table below.

Angle	$i \pm 1°$	35	40	45	50	55
	$\sin i$					
Angle	$r \pm 1°$	23	25	28	31	33
	$\sin r$					

(a) Complete the table, giving the values of sine to three significant figures. (2 marks)

(b) Graph $\sin i$ vs $\sin r$ on the graph below. Include a line of best fit. (3 marks)



A spare grid is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare grid.

(c) The refractive index of air (n_1) is 1.00. Using your line of best fit, determine the refractive index of the prism (n_2). Indicate clearly which two points on your line of best fit you used in your calculation. Give your answer to two significant figures. (4 marks)

Answer _____

(d) There are two phenomena described in this question that support the wave behaviour of light. List them below. (2 marks)

One: _____

Two: _____

(e) The tolerance for all angles was ± 1°. How does the percentage error change as the angle measured increases? Use calculations in your answer. (3 marks)

(f) Using the following trigonometric identity, calculate the percentage error of the sine of an angle of incidence of 50.0°. (4 marks)

$$\sin (A \pm B) = \sin A \cos B \pm \cos A \sin B$$

Answer _____ %