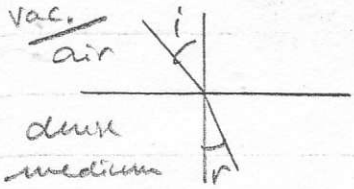
Light + Refraction

A Physics

Snell's Law



$\frac{\sin i}{\sin r} = \mu$ or n (refractive index)

Waves

$V_{air} = 3 \times 10^8$ m/s

$n_{air} = 1.00$

$n_{glass} = 1.5$

$n_{water} = 1.33$.

A. Simple Refraction

1 A student measures the refractive index of a new type of glass, using this data

i	12	48
r	8	32

(a) Calculate the mean value of μ.

(b) What is the velocity of light in this glass?

(c) What is the critical angle will this glass have?

Draw a diagram to show your answer, and explain what "critical angle" means.

(d) Will this glass be any good for making prisms for a periscope? Explain your answer.

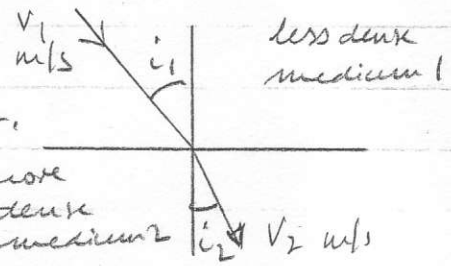
2 The refractive index of a glass is 1.514 for red light, and 1.513 for blue light. Calculate the velocities of each light in the glass.

B. More advanced refraction

data sheet

Here, $\frac{\sin i_1}{\sin i_2} = \frac{V_1}{V_2} = \frac{n_2}{n_1}$ — ref. index of medium 2, ref. index of medium 1.

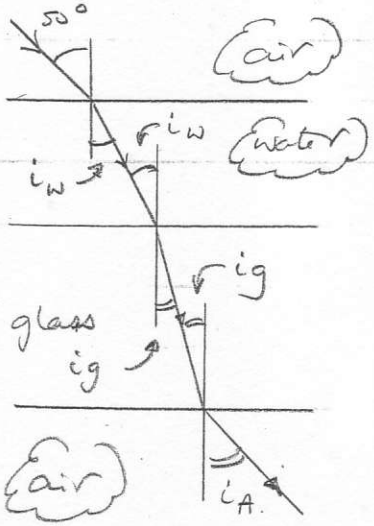
$(V_1 > V_2)\ (n_2 > n_1)$



So... $n_1 \sin i_1 = n_2 \sin i_2$ (data sheet)

1 The diagram shows some water in the bottom of a glass. A light ray shines through.

Can you calculate all the angles?



TN
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Light + Refraction – Answers

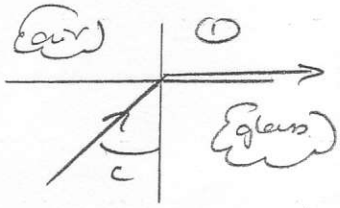
A Physics

A. 1. $\mu = \frac{\sin i}{\sin r}$ = 1.49 ① and 1.40 ① μ mean = 1.45 ① /1

(b) $\mu = v_{air}/v_{glass}$ ① $\rightarrow v_{glass} = 3\times10^8/1.45 = 2.07\times10^8$ m/s (2.1) ① /2

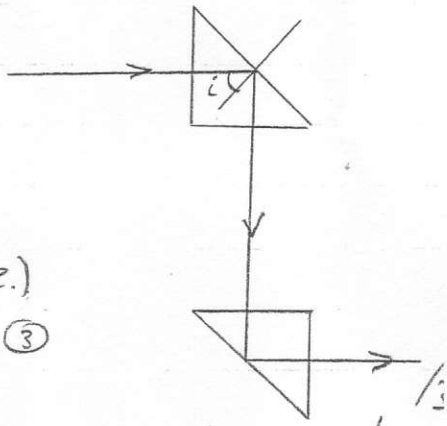
(c) recall $\mu = \sin 90/\sin c \rightarrow \sin c = \frac{1}{\mu}$ ①

So critical angle c = 43.7° ① /2



Critical angle is the largest incident angle possible for the light to escape the glass, and not be totally internally reflected. ① /4

(d) The diagram shows a simple prism periscope → For this to work critical angle c must be less than 45°. (when i = 45°, i > c, and you get T.I.R.) So the glass will be ok for a prism. ③



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(e) $v_{red} = v_{air}/\mu_{red} = 1.982\times10^8$ m/s ② $v_{blue} = v_{air}/\mu_{blue} = 1.983\times10^8$ m/s ① accuracy! /3

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B

1. For air/water $n_{air}\sin i_{air} = n_{water}\sin i_{water}$

So $\sin i_w = 1.00\times0.766/1.33 = 0.576$

So angle i_w = 35.67 (35.2)° ②

For water/glass $n_{water}\sin i_w = n_{glass}\sin i_g$

So $\sin i_g = 1.33\times0.576/1.5 = 0.511$

So angle i_g = 30.7° ②

For glass/air $n_{glass}\sin i_g = n_{air}\sin i_{air}$

So $\sin i_{air} = 1.5\times0.511/1 = 0.766$

So angle i_{air} = 50° (phew!) ②

So the ray emerges parallel but to one side of its original path

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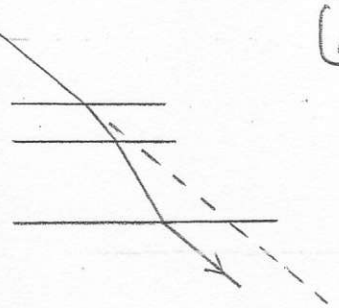

TLW

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