

Light - Refraction - 2

A Physics

data:

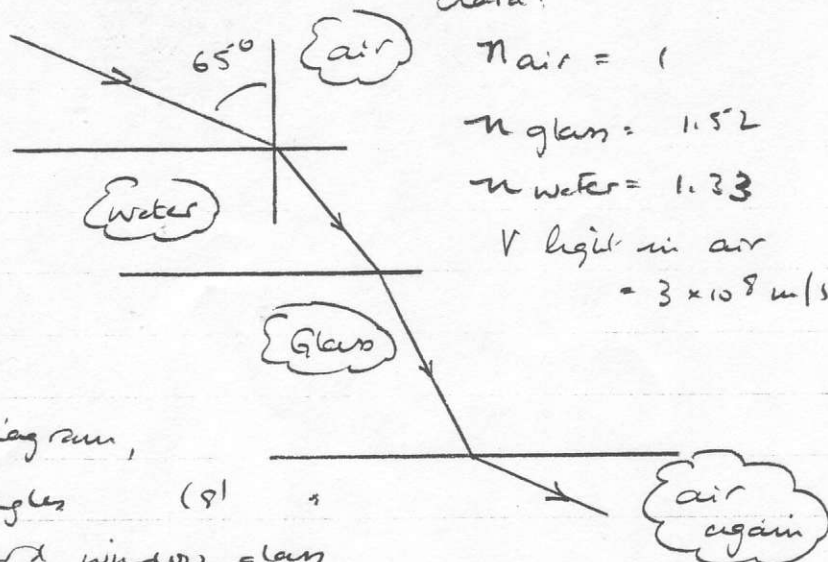
$$n_{\text{air}} = 1$$

$$n_{\text{glass}} = 1.52$$

$$n_{\text{water}} = 1.33$$

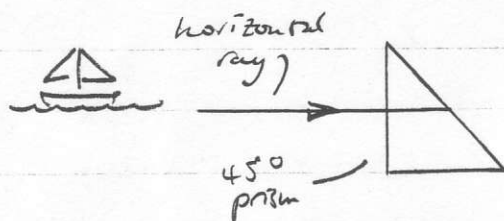
$$v_{\text{light in air}} = 3 \times 10^8 \text{ m/s}$$

1. The diagram shows a ray of light entering a layer of water resting on a horizontal window in a flat roof.



- (a) Copy and complete the diagram, and calculate all angles. (8)
- (b) If the glass is standard window glass 4 mm thick, how long does the light ray take to go through it? (4)

2. The diagram shows part of a simple periscope for a submarine.

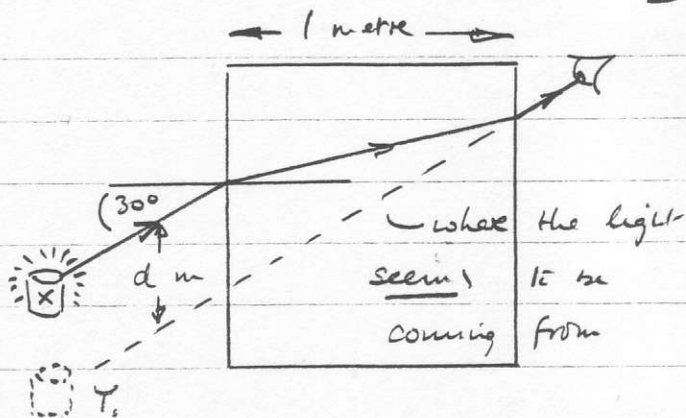


- (a) Copy and complete the diagram, showing all prisms and angles, and light going into the eye. (4)
- (b) The Navy research lab are testing a new glass for the prisms. It is very light, clear, and has a super-low refractive index of 1.38.

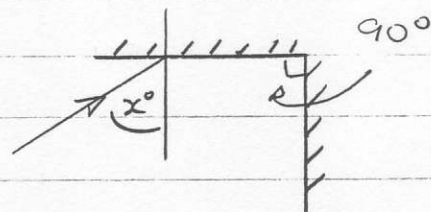
Will this glass work in the prisms? Explain your answer. (3)

3. People handling radioactive substances work behind a very thick glass screen. The screen is so thick that the object seems to have moved.

Calculate distance d , the apparent error in position. (6)



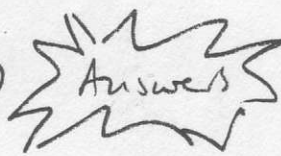
- 4 (a) Show that any light ray will be reflected by the two mirrors at 90° to go back parallel to its original path. (3)



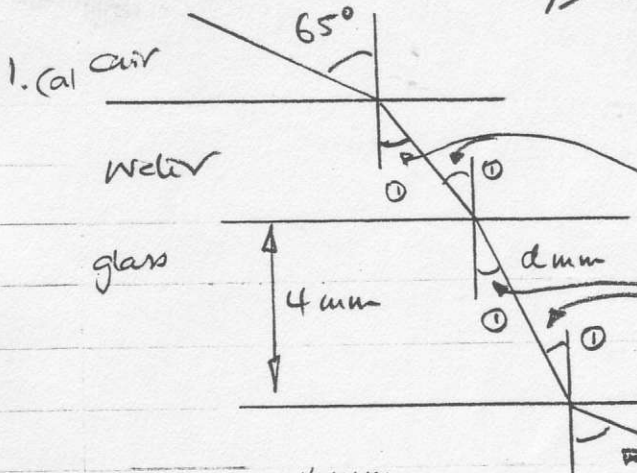
- (b) What effect does this have on the image? Sketch the image of "Scarface" in (1) a single mirror (2) in the double mirror shown. (3)



Light - Refraction ②



A Phys. i



$$n \sin i = \text{const} = 0.906$$

$$\text{So } n \sin i_w = 0.906 \text{ so } i_{\text{water}} = 42.96^\circ = 43.0^\circ$$

$$i_w = 43.0^\circ$$

$$n_g \sin i_g = 0.906$$

$$\text{So } i_g = 36.6^\circ$$

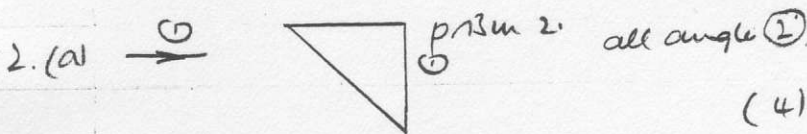
back to $i_{\text{air}} = 65^\circ$

(b) $\cos 36.6 = \frac{4 \text{ mm}}{d}$, So distance travelled by light in glass $d = 5.0 \text{ mm}$

Time to go through glass $t = d / v_{\text{glass}}$

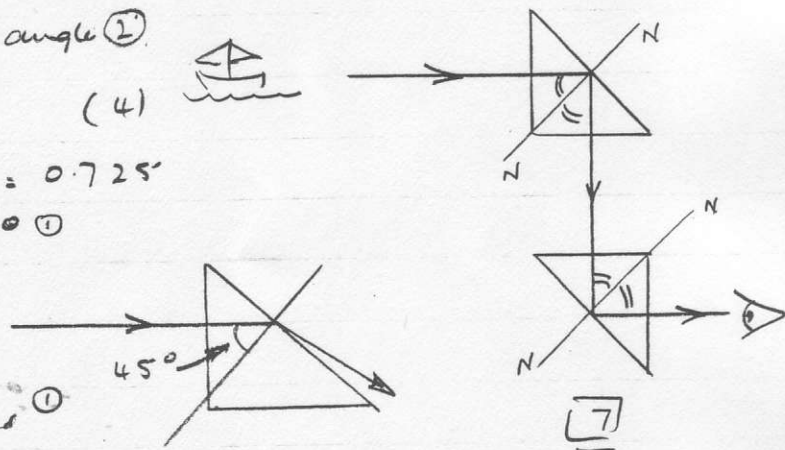
$$v_{\text{glass}} = v_{\text{air}} / n_{\text{glass}} = 3 \times 10^8 / 1.52 = 1.97 \times 10^8 \text{ m/s}$$

$$\text{So time } t = \frac{5 \times 10^{-3} \text{ m}}{1.97 \times 10^8} = 2.5 \times 10^{-11} \text{ sec (not long!)}$$



(b) If $\mu = 1.38$ then $\sin c = \frac{1}{\mu} = 0.725$
and crit. angle $c = 46.4^\circ$

this means that in the prism angle $i < c$, so light ray is not internally reflected



3 Distance $d = \text{distance } y$.

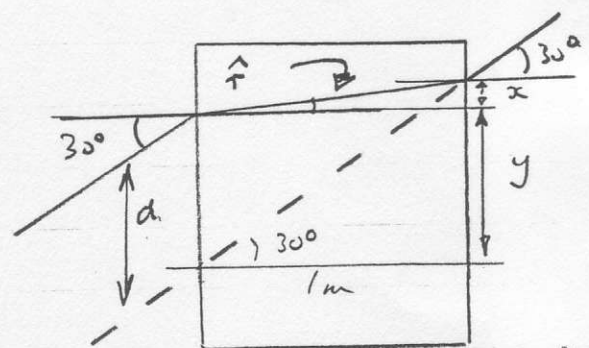
$$\tan 30 = (x+y)/1, \text{ so } (x+y) = 0.577 \text{ m}$$

$$\tan r = x/1$$

$$n_{\text{glass}} = \frac{\sin 30}{\sin r} \text{ so } r = 19.2^\circ$$

$$\text{So } \tan 19.2 = x/1 \text{ so } x = 0.348 \text{ m}$$

$$\text{So distance } d = (x+y) - x = 0.577 - 0.348 = 0.23 \text{ m}$$



4 (a) See steps in diagram (3)

(b) The image is not apparently reversed.

