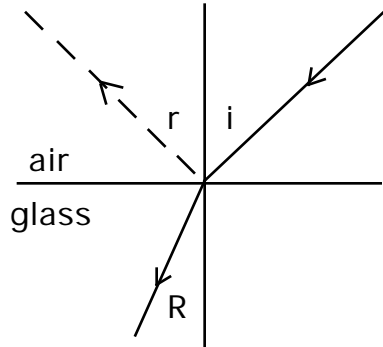
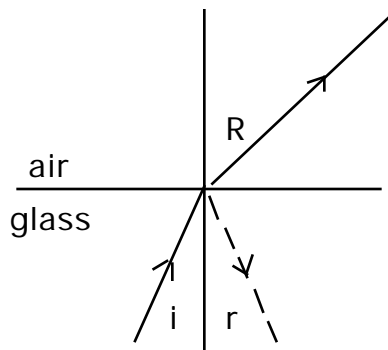


Refraction : Notes/W.S.-20

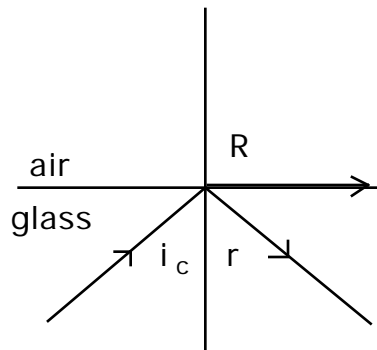
When a light ray enters a piece of glass, some of the light is reflected, but most is refracted.



When a ray of light travels from glass to air, the ray bends away from the normal. Some of the light is reflected inwards.



At a certain angle, known as the critical angle, i_c , the angle of incidence is such that the angle of refraction R , is equal to, 90° .



If the angle of incidence is greater than the critical angle, all of the light will be reflected inwards. This phenomenon is known as total internal reflection.

Assume that the index of refraction for glass is 1.50. We can find i_c by using Snell's Law.

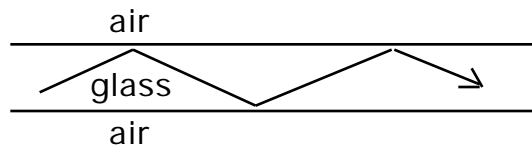
$$\frac{\sin(i)}{\sin(R)} = \frac{1}{n}$$

$$\frac{\sin(i_c)}{\sin(90)} = \frac{1}{1.50}$$

Solving this equation, we find that $i_c = 41.8^\circ$.

Example:

In a light pipe, or a fiber optic cable (a thin cylinder of glass), a light signal can be transmitted with very little loss of energy because of the phenomenon of total internal reflection.



Problems:

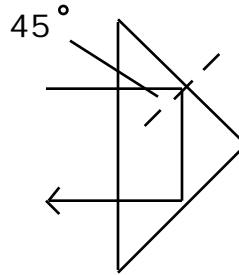
1) Find the critical angle i_c , for the following substances.

- a) water ($n = 1.33$)
- b) glass ($n = 1.52$)
- c) diamond ($n = 2.42$)

2)a) The critical angle for a ruby (corundum, Al_2O_3) crystal is 40.5° . Find the index of refraction.

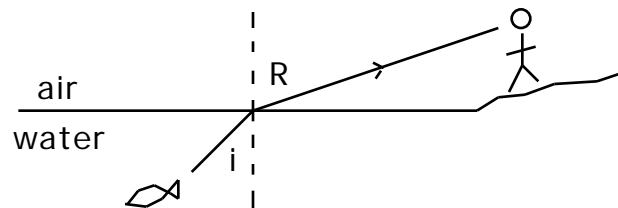
b) The critical angle for a certain plastic is 45.6° . Find the index of refraction.

3)a) A 45-45-90 glass prism is used in binoculars. The prism changes the direction of light rays by 90.0 degrees, as shown below. There must be total internal reflection. Find the minimum value of the index of refraction for the prism.



b) Explain why glass (not plastic, see problem 2b) should be used for prisms.

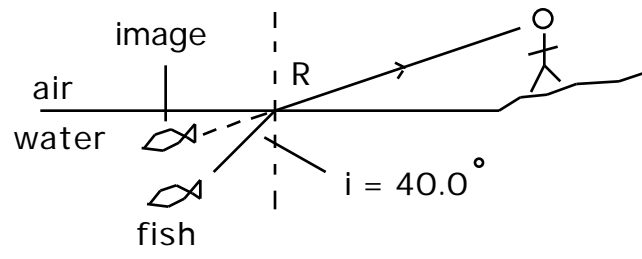
4)a) A boy sees a fish in a pond. If the angle of incidence "i", = 40° , find the angle of refraction R.



b) Draw the apparent position of the fish.

c) As the fish swims away from the man, it seems to "disappear". What is the angle of incidence "i", when this happens.

Answers: 1)a) 48.8° , b) 41.1° , c) 24.4° , 2)a) 1.54, b) 1.40, 3)a) 1.41, b) The critical angle for plastic is greater than 45.0° . Some light will leave the prism., 4)a) 58.7° , b)



c) 48.8° .