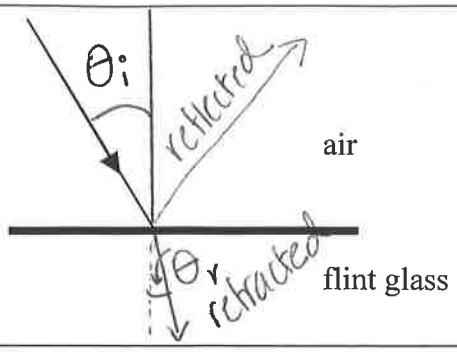
Snell's Law of Refraction

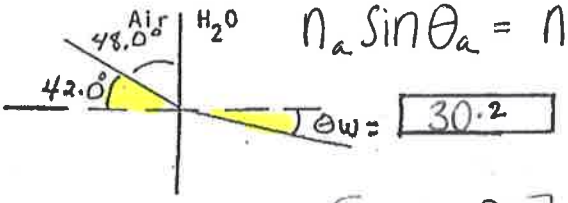
Snell's Law (Law of Refraction)

$n_1 \sin\theta_1 = n_2 \sin\theta_2$ $\quad \frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1}$

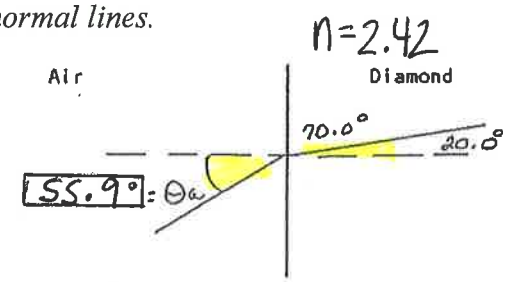
Use Snell's law to construct the refracted ray on the diagram at right.



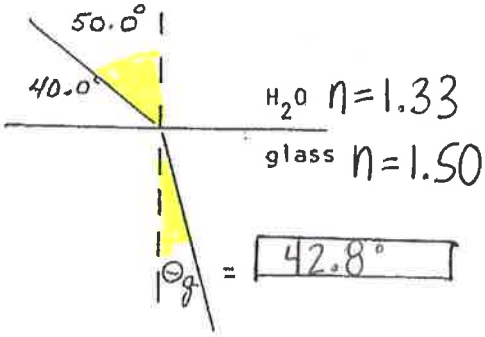
P.486 Use a Snell's law to determine and draw the path light takes in the material as shown. *Note: Indices are in the text. Also, not all interfaces are horizontal. Dotted lines are the normal lines.*



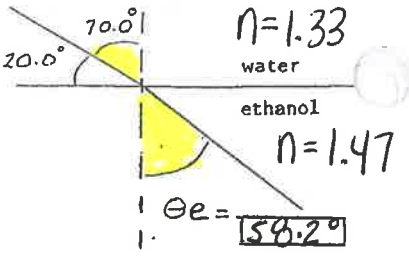
$n_a \sin\theta_a = n_w \sin\theta_w$ $\quad n_{air} = 1.00$ $\quad n_{water} = 1.33$



$\theta_w = \sin^{-1}\left[\frac{n_a \sin\theta_a}{n_w}\right]$



$\theta_g = \sin^{-1}\left[\frac{n_w \sin\theta_w}{n_g}\right]$



"c" = speed of light

Refraction and Wavelength

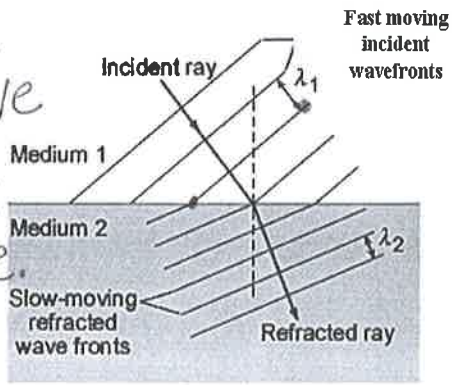
"v" = all wave speeds

Why does refraction occur?

because one part of the incident wave changes speed before the rest of the wave

As the wave enters a more optically dense medium . . .

wavelength decreases, speed decreases the frequency or period remains the same.



Relationship: $c = \lambda f$ $\quad v_{wave\ speed} = \lambda f$

$n = \frac{c}{v}$ $\quad \frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{c/v_1}{c/v_2} = \frac{v_2}{v_1} = \frac{\lambda_2 f}{\lambda_1 f}$

A beam of monochromatic yellow light with a frequency of 5.09×10^{14} Hz enters a block of diamond from air.

a) What is the frequency of the light in the diamond?

b) What is the wavelength of the light in air?

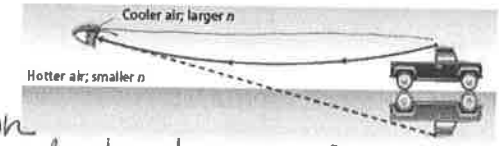
c) What is the wavelength of the light in the diamond?

d) What is the speed of the light in the diamond?

Optical Effects due to Refraction

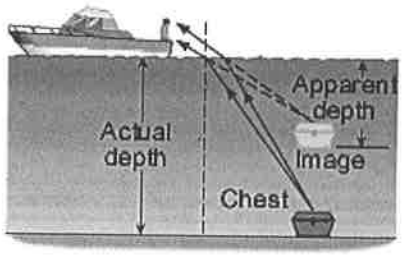
eye thinks ray from pencil in water is in a different place due to refraction

Mirages

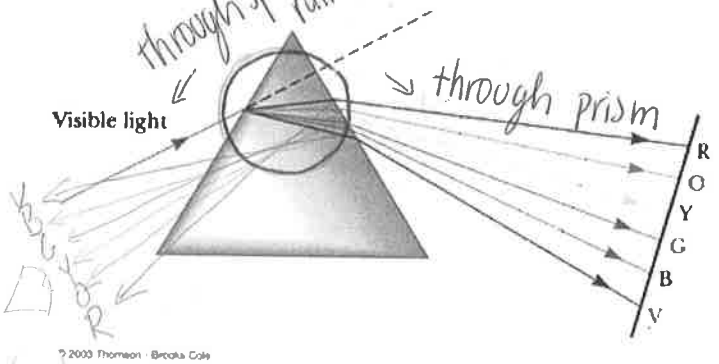


light bends away from normal as it goes from cold to hot; hot air has lower "n" so ray speeds up

Apparent Depth



Dispersion:



Red: bends the least away from normal

Violet: bends the most away from normal

Explanation: Each frequency of has a slightly different index of refraction or the amount it bends

Dispersion Rule:

Red Resists Refraction
Blue Bends Best