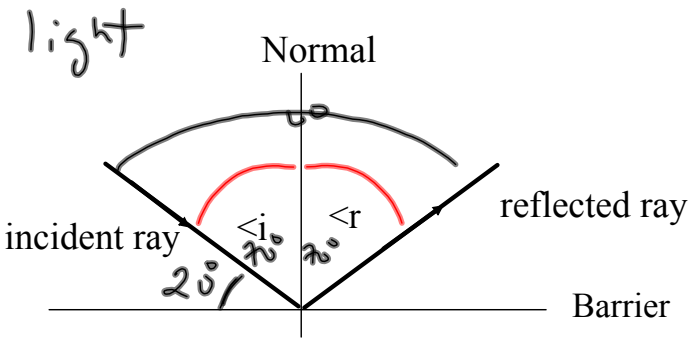
Wave Behaviors

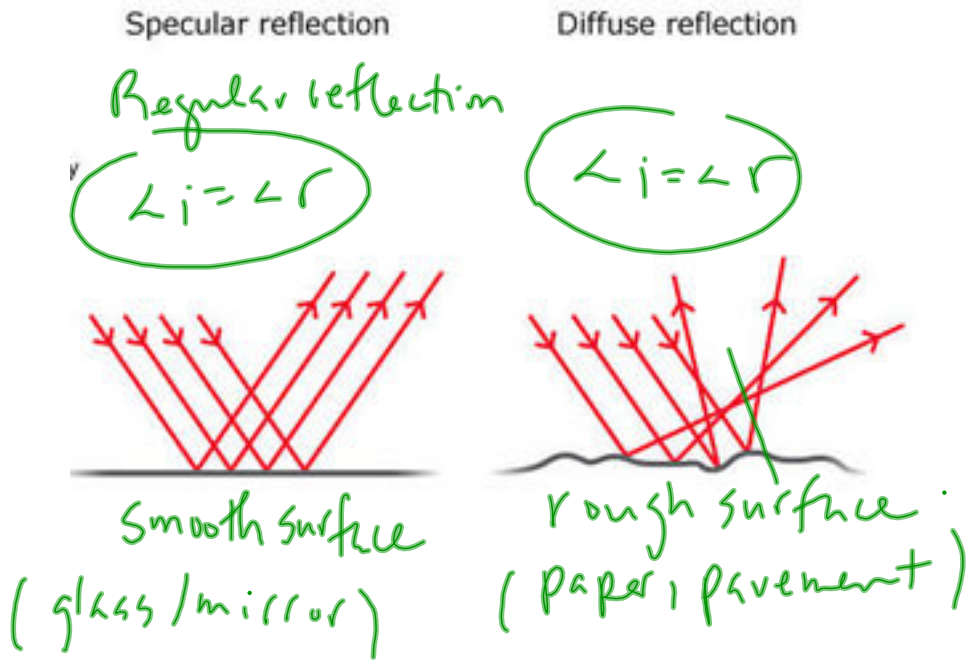
Reflection

1 medium



The Law of Reflection: The angle of incidence (<i) equals the angle of reflection (<r).

<i = <r



Refraction

2 mediums/media

-> the bending of a wave as it passes from one medium to a different medium when the wave approaches a boundary at an angle other than 0^o

*** We will be concentrating on the refraction of light.**

The index of refraction of a medium gives us an indication of the degree of bending that a light ray undergoes.

Indices of Refraction

symbol (n)

Substance	Index (No Units)
vacuum	1.00
air	1.0003 -> 1.00
ice	1.31
water	1.33
ethanol	1.36
diamond	2.42

MORE ON PAGE 397

Meter Stick Demo

When light travels from one medium to another, its speed changes.

$$v_s = \frac{c}{n_s}$$

v_s -> speed of light in a substance (m/s)
$c = 3.00 \times 10^8$ m/s
n_s -> index of refraction of the substance

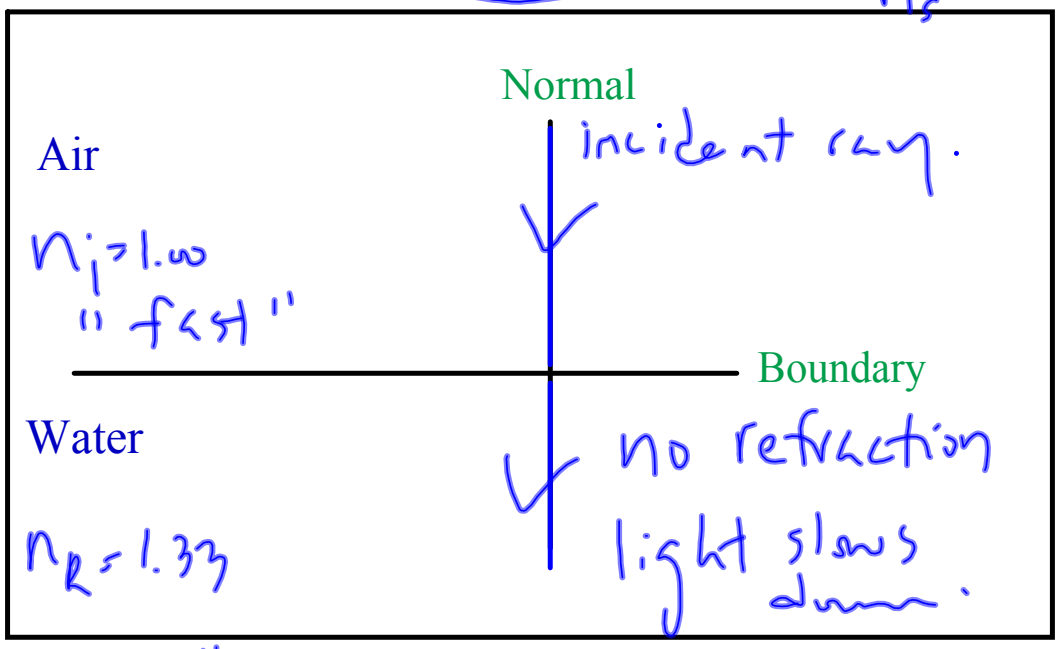
Worksheet: #1-2

First Medium	Second Medium
<i	<R
n_i	n_R

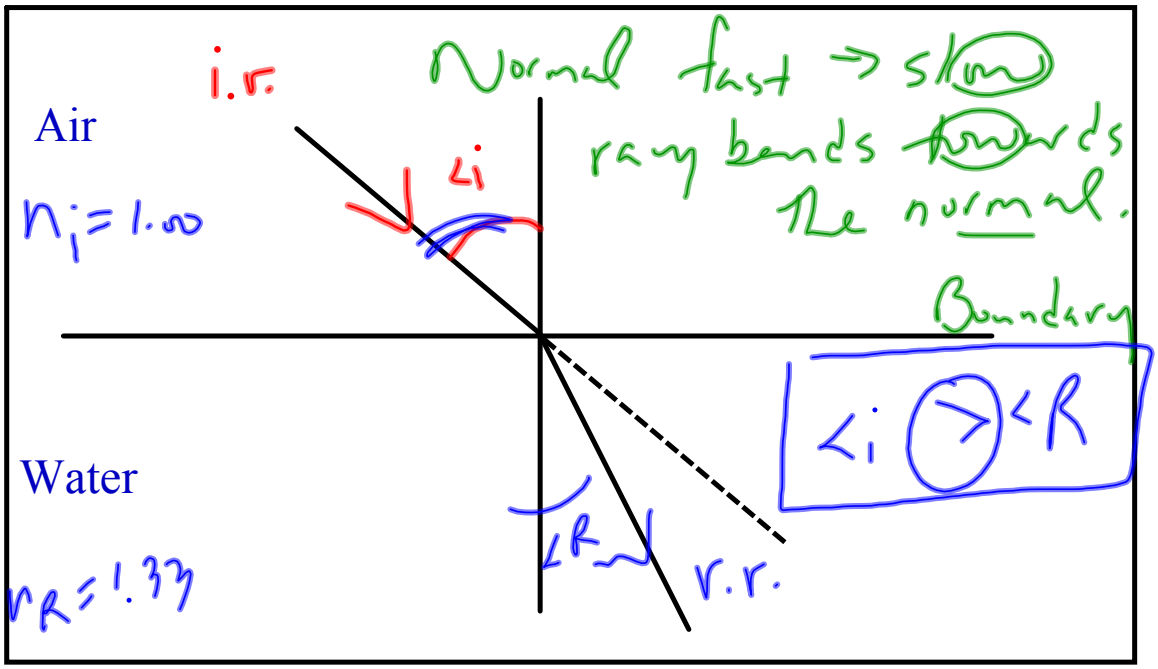
i- incident R - refraction

Case #1: $<i = 0^o$, $n_i < n_R$

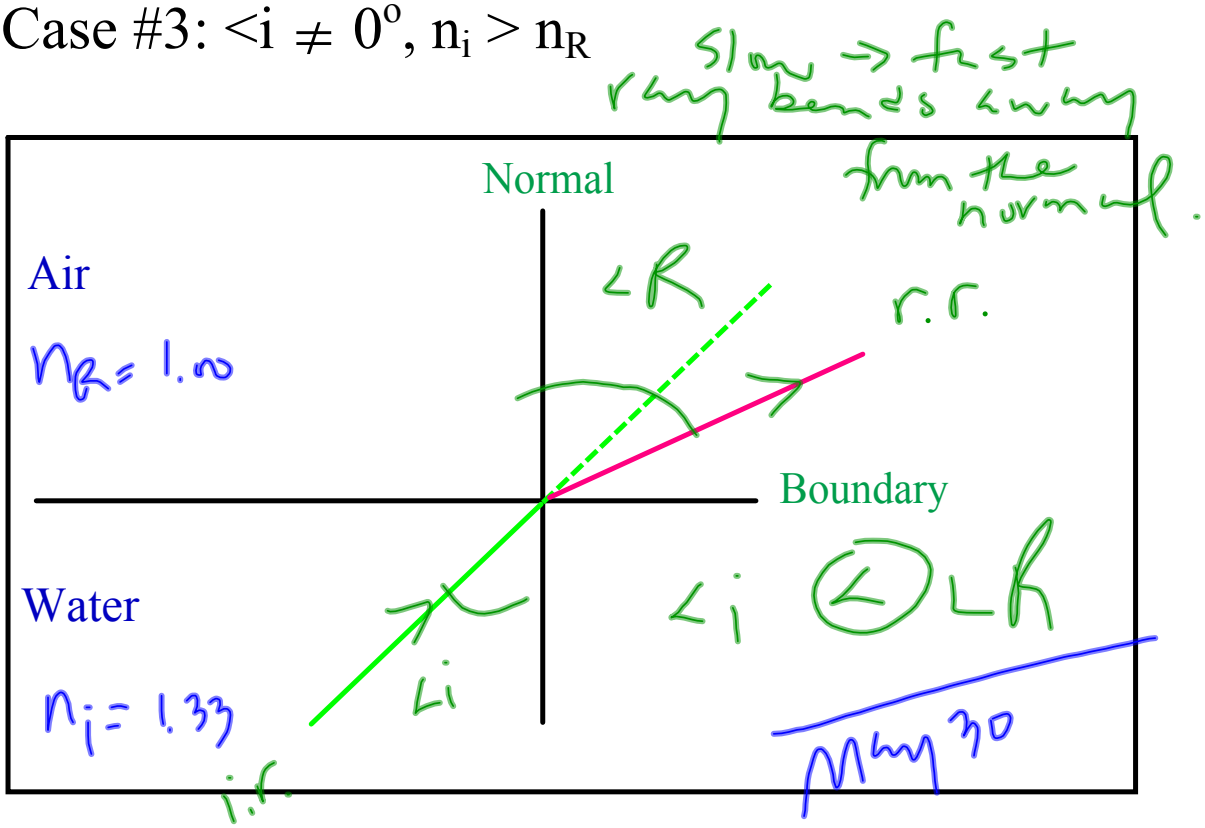
$v = \frac{c}{n_s}$



Case #2: $<i \neq 0^o$, $n_i < n_R$



Case #3: $<i \neq 0^o$, $n_i > n_R$



http://www.haverford.edu/physics-astro/songs/snell.htm

Snell's Law Song

Words by Marian McKenzie & Walter Smith 12-8-02

Tune: Sweet Betsy from Pike (traditional)

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

C C G7 C
Come listen and learn, I've a story I tell,
C Am G G7
I sing of the genius of Willebrord Snell
C Em F C
A mathematician who lived long ago
C C G7 C
In the Netherlands where the Rhine river does flow.

C C G7 C
He set for his mind occupations of worth,
C Am G G7
Improved navigation and measured the Earth!
C Em F C
He gave us the sine law, that wonderful guy,
C C G7 C
And he made more precise calculation of pi!

Willebrord van Roijen Snell
1580-1626
(Note that the first name is actually pronounced "Villbrort", but in the song is pronounced "Vill-e-brort".)

C F (or C) G (or G7) Am (or C)
Singin' n1 sine theta-sub-1, hey, hey, hey,
C F (or C) G (or G7) C
Equals n2 sine theta-sub-2, hip hooray!

C C G7 C
His greatest feat came in Sixteen Twenty-one,
C Am G G7
When optics as science was really begun!
C Em F C
While flashes of lightning illumined his page,
C C G7 C
He wrote down Snell's law, his great gift to the age!

C C G7 C
So if you wear glasses or like to fry ants,
C Am G G7
Be grateful your lenses were not made by chance!
C Em F C
Astronomers hail him with each new-found star!
C C G7 C
Microscopists toast him from each sleazy bar!

C F (or C) G (or G7) Am (or C)
Singin' n1 sine theta-sub-1, hey, hey, hey,
C F (or C) G (or G7) C
Equals n2 sine theta-sub-2, hip hooray!

C C G7 C
Now some credit Harriot, others Descartes,
C Am G G7
Both studied refraction, and both were real smart.
C Em F C
But we prefer Willebrord van Roijen Snell --
C C G7 C
He laid down the law, and he did it darn well!

C F (or C) G (or G7) Am (or C)
Singin' n1 sine theta-sub-1, hey, hey, hey,
C F (or C) G (or G7) C
Equals n2 sine theta-sub-2, hip hooray!

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Snell's Law

Snell's Law states that the product of the index of refraction of the first medium (n_i) and the sine of the angle of incidence (sin i) is equal to the product of the index of refraction of the second medium (n_R) and the sine of the angle of refraction (sin R).

$$n_i \sin i = n_R \sin R$$

*Make sure your calculator is in degrees!

Example:

A light ray strikes an air/water surface at an angle of 46° with respect to the normal. Find the angle of refraction. (33°)

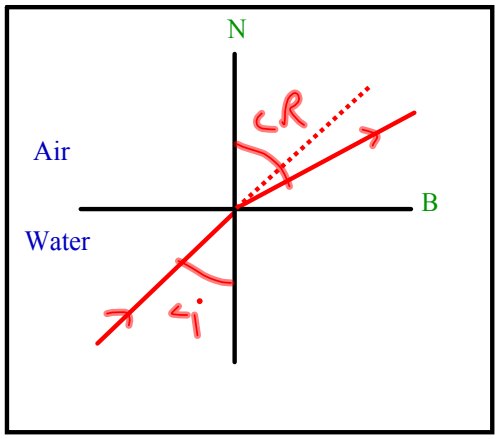
Worksheet -> #3-13

Critical Angle

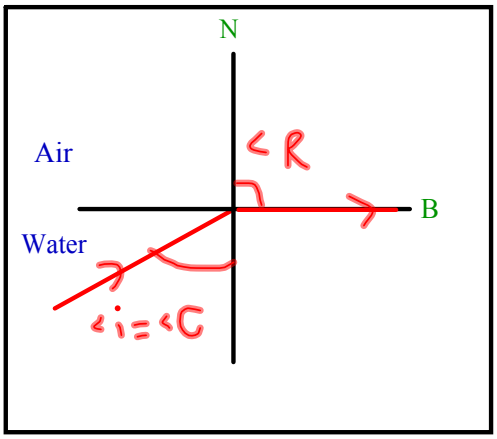
Critical Angle -> Special Angle of Incidence

A critical angle is possible only if light travels from a more dense medium to a less dense medium (ie/ water to air).

Case #3



Critical Angle



$n_i \sin i = n_R \sin R$

$n_i \sin c = n_R \sin R$

$\angle R = 90.0^o$

$\sin 90.0^o = 1$

$n_i \sin c = n_R$

If the less dense medium is air, $n_R = 1.00$.

$n_i \sin c = 1.00$

$$\sin c = \frac{1}{n_i}$$

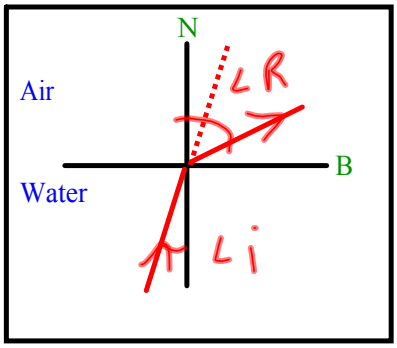
critical ∠ in air is 90°.

☆

Total Internal Reflection

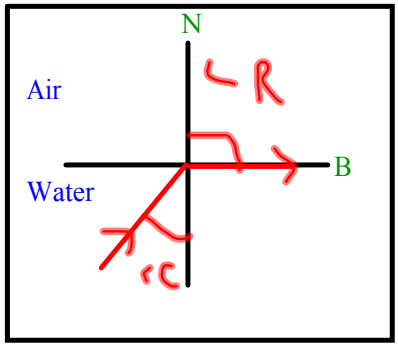
Total internal reflection is possible only when light travels from a more dense medium to a less dense medium (ie/ water to air).

Case #3



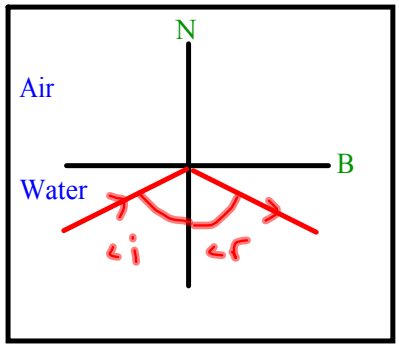
$<i$ (<) $<c$

Critical Angle



$<i$ (=) $<c$

Total Internal Reflection



$<i$ (>) $<c$

Worksheet: #14-20

Lab - The Speed of Light (Refraction)

Lab Format

Names:

Due Date:

Title: Experiment 36 - Speed of Light in "Glass"

Problem:

Apparatus:

Procedure: Refer to the lab handout.

(7)

Gathering the Data:

Draw, label and submit diagrams for angles of incidence from 0^o to 60^o.

Complete Table 36-1 (14)

Solving the Problem:

Graph the sines of the angles of incidence versus the sines of the angles of refraction as directed in the lab handout. (4)

Determine the index of refraction of the "glass". Show your work. (2)

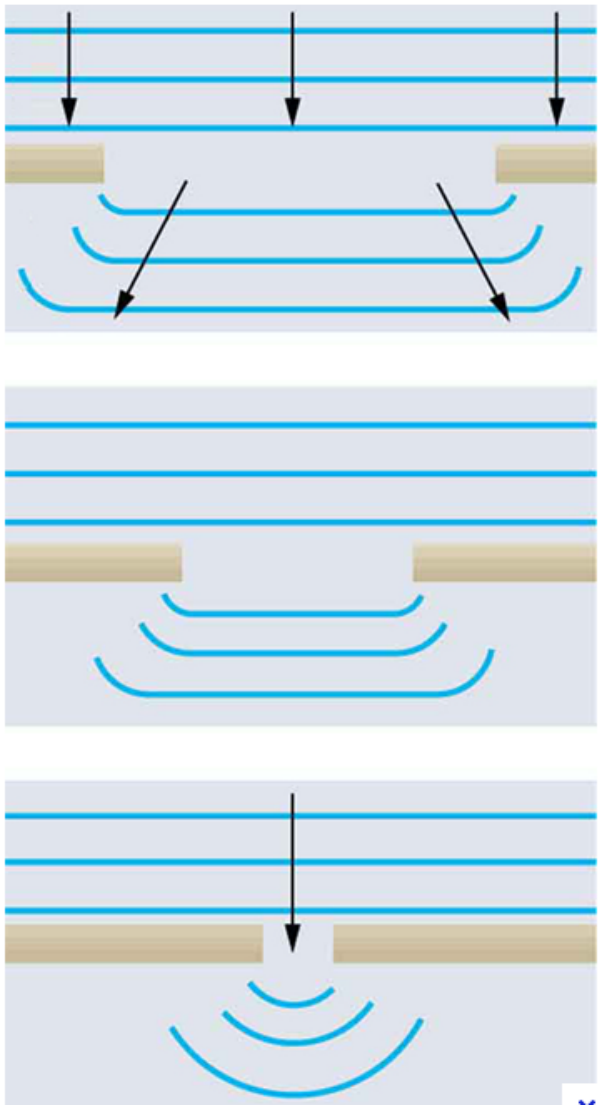
Calculate the speed of light in the "glass". Show your work. (2)

Δ

Diffraction

1 medium

Diffraction is the bending of a wave around a barrier such as an obstacle or the egdes of an opening. When the opening is wide compared to the wavelength of the wave, the spreading effect is small. As the opening becomes narrower, the spreading of the wave is more pronounced.



Attachments

- P112 - Superposition.notebook
- P111-112 Lab Resonance.notebook