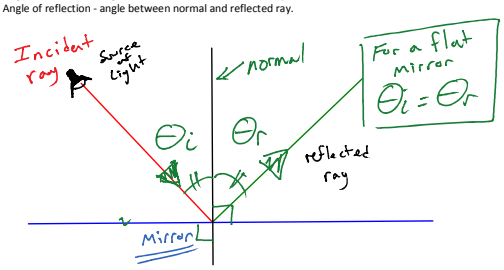
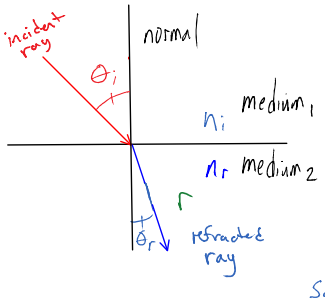
Refraction, Reflection

September 8, 2015 1:24 PM

Laws of Reflection: When a wave hits a reflective surface it bounces off the surface with the same angle of reflection as angle of incident.
Incident ray - approaching mirror
Reflected ray- leaving mirror.
Normal-line at 90 degrees to the surface of the mirror.
Angle of incidence - angle between normal and incident ray.
Angle of reflection - angle between normal and reflected ray.

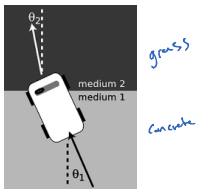


Refraction: When a wave transfers from one optically dense medium into a different optically dense medium, the wave bends.



Index of refraction $n = \#>1$
(Optical density of the Medium)

$n_i \sin\theta_i = n_r \sin\theta_r$ (Snell's Law)



Sample N
Vaccuum = 1.00
Air = 1.00033 (Just use 1.00)
water = 1.33
Quartz glass = 1.54

θ_i : Angle of incident
θ_r : Angle of refraction
n_i : index of refraction for the incident medium
n_r : index of refraction for the refracting medium

Low optically dense medium to High optically dense medium :: wave bends towards the normal
High optically dense medium to Low optically dense medium :: wave bends away from the normal

Index of Refraction and the speed of light
As light passes through an optically dense material light slows down. We use this speed to determine the index of refraction.
The index of refraction is measured as the ratio of the speed of light in vacuum to the speed of light in the material.

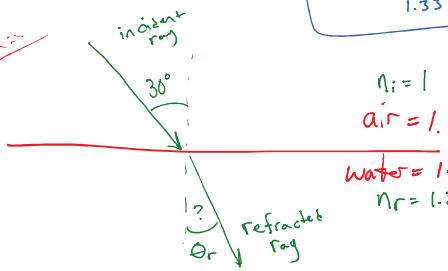
$n' = \frac{c}{v'}$

n' : index of refraction of the material
c : speed of light in vacuum (3.00×10^8)
v' : speed of light in the material

What is the speed of light in water? (n=1.33)

$1.33 = \frac{3 \times 10^8}{V}$

$V = \frac{3 \times 10^8}{1.33} = 2.26 \times 10^8$ m/s



$n_i = 1$ air $= 1$
water $= 1.33$
$n_r = 1.33$

$n_i \cdot \sin\theta_i = n_r \cdot \sin\theta_r$

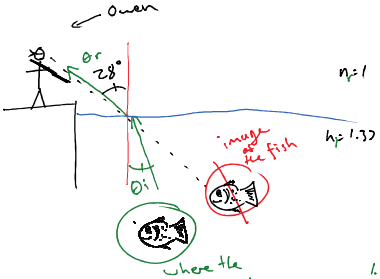
$1 \cdot \sin 30 = 1.33 \sin\theta_r$

$\frac{0.5}{1.33} = \frac{1.33\sin\theta_r}{1.33}$

$0.3759 = \sin\theta_r$

$\sin^{-1}[0.3759] = \sin^{-1}[\sin\theta_r]$

$22.1° = \theta_r$



Hunter wants to hit the fish with the Spear
what angle is the light coming from below the waters Surface?

$n_i \sin\theta_i = n_r \sin\theta_r$

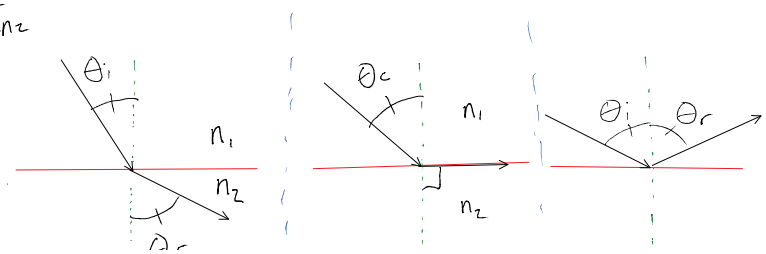
$\frac{1.33\sin\theta_i}{1.33} = \frac{1\cdot\sin 28}{1.33}$

$\theta_i = \sin^{-1}[0.3530]$

$\theta_i = 20.7°$

Critical Angle
When a wave passes from a high optically dense medium to low optically dense medium the wave bends away from the normal line

For $n_1 > n_2$



As we increase θ_i, θ_r approaches the surface.

The critical Angle θ_c, makes $\theta_r = 90°$

If $\theta_i > \theta_c$ then we get total reflection

$$\sin\theta_c = \frac{n_r}{n_i}$$

Ex: What is the critical angle for light passing from quartz glass ($n = 1.54$) to air ($n = 1.00$)?

$$\sin\theta_c = \frac{1.00}{1.54}$$

$$\theta_c = \sin^{-1}\left[\frac{1.00}{1.54}\right]$$

$$\theta_c = 40.5°$$

Any angle $> 40.5°$ will result in total reflection