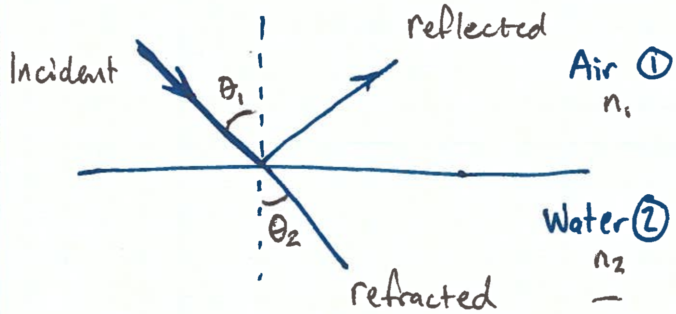
Snell's Law, Index of Refraction, Huygen's Principle

INCIDENT SIGNAL FROM AIR TO WATER



Note:

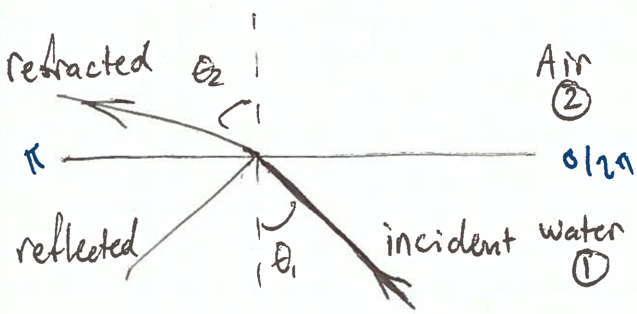
(1) All rays are in same plane!

(2) Reflected ray reflects at same angle (θ_1) as incident

(3) $n_1 \sin\theta_1 = n_2 \sin\theta_2$ [Snell]

n is the index of refraction

Now consider case from water to air...



We know $n_{water} = n_1 = 1.3$ and

$n_{air} = n_2 = 1$

The max value for θ_2 is 90°

so at $\theta_2 = 90°$ we have

$$\frac{\sin\theta_1}{\sin(90°)} = \frac{1}{1.3}$$

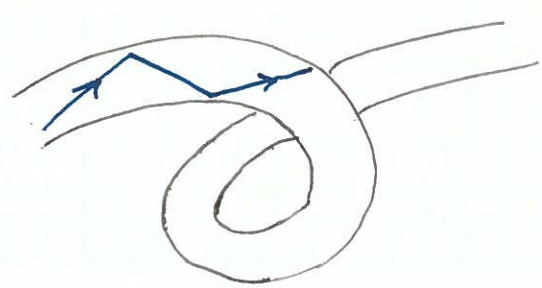
we get $\theta_1 = 50°$.

$n = \sqrt{k k_m}$

This means the signal is completely reflected (no refraction) when $\theta_1 > 50°$ (this is called total reflection!)

DEMO: Laser reflected off surface of water, reflection & refraction

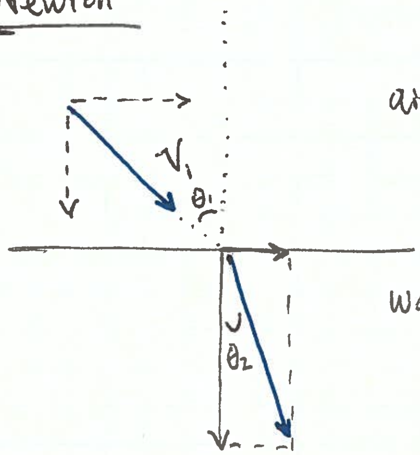
Application: Fiber Optics



DEMO: Laser in fiber optic cable

- light propagates through cable no matter wire orientation
- Lewin sends image over FO cable

Newton

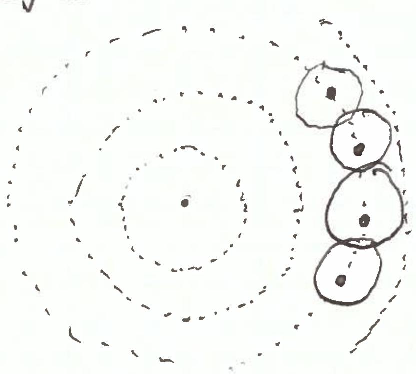


Particle approach, Newton

$$\frac{\sin \theta_1}{\sin \theta_2} = \frac{V_2}{V_1}$$

Velocity parallel to media boundary is the same before and after entering the new media

Huygen : "velocity is wave not particle"



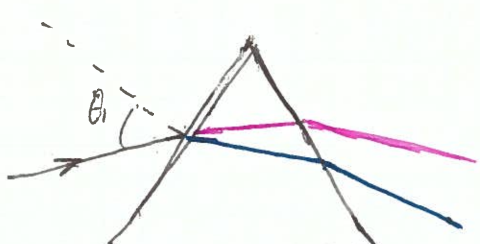
- each point along the wave front oscillates at the same frequency as the source
- the new wavefront is found from the envelope of the previous front
- speed of light in water is lower than in air

DISPERSION

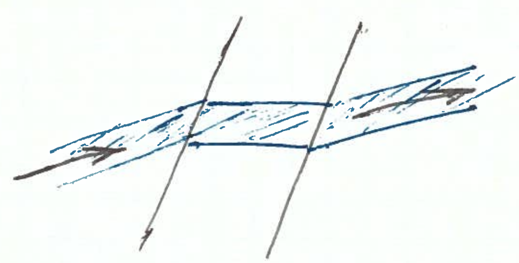
$\boxed{n = c/v}$ (V is phase Velocity in medium)

lights are differentiated by frequency, index of refraction is frequency different so they travel at different velocities

In water: $n_{red} = 1.331$, $n_{blue} = 1.343$



PRISM

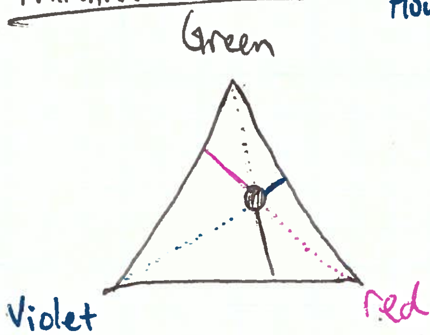


WINDOW

DEMO: took wheel with all colors and spun it fast now it looks completely white!

PRIMARY COLORS

How to mix primary colors to create new color of choice...



When primary colors don't work

Benham's Top 

Ewin Land Altered clown pictures