Phys 2426 2017-11-16 Lec 22

A car stereo produces 96 dB sound (with all speakers) at a distance of 3.0 m. What sound level is produced at 15 m if half of the speakers are blown out?

$$I = \frac{P}{4\pi R^2} \qquad \text{(Point Source)}$$

Power: Cut in half

Dist: Increase by 5 times

Intensity: $\frac{0.5}{3^2} = \frac{1}{50}$

What dB level is a factor of 50?

$10^{1.7} = 50$ 17 dB

Final level is 96 dB − 17 dB = 79 dB

$\text{Ratio} = 10^{x}$ $\beta = 10x$ dB level

$\beta = 10 \log(\text{Ratio})$

$\text{Ratio} = 10^{\beta/10}$

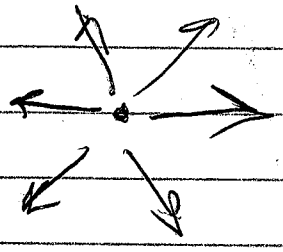
Optics - redirecting waves

Geometric Optics - Using the shape of a medium to control waves.

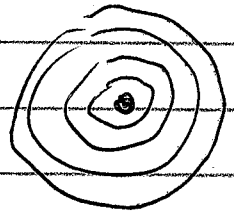
Two main effects
- Reflection - bouncing waves off a surface.
- Refraction - bending waves as they are transmitted into a new material.

Rays - Like a laser beam. Points in direction of energy flow.

Wave Fronts - Perpendicular to rays, these are the peaks and valleys of 2D & 3D waves.

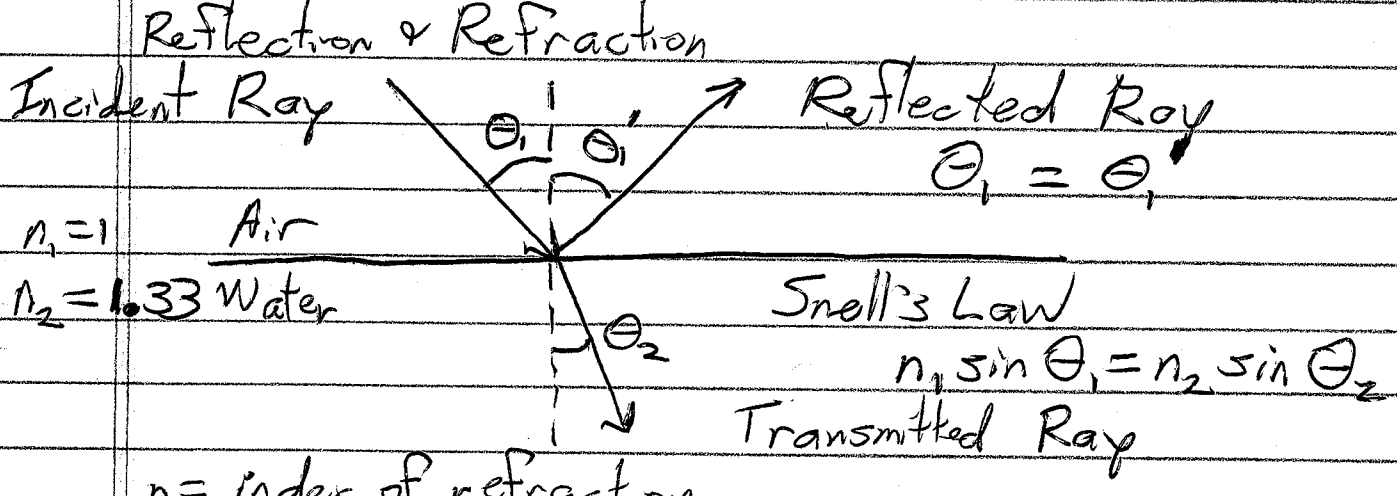


Rays



Wave Fronts

Reflection & Refraction




n = index of refraction

Ex: $n_1 = 1$ $n_2 = 1.33$

$\theta_1 = 45°$

$(1)\sin(45°) = 1.33 \sin\theta_2$

$0.532 = \sin\theta_2$

$\theta_2 = 32°$

When the index of refraction increases, the ray bends toward the normal.

Ex: $n_1 = 1.33$ $n_2 = 1$

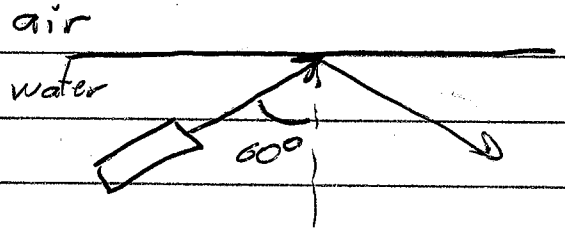
$\theta_1 = 60°$

$1.33 \sin(60°) = 1 \sin\theta_2$

$1.15 = \sin\theta_2$

There is no $\theta_2$!

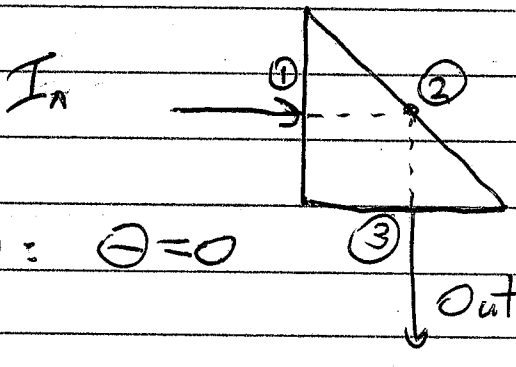
No transmitted light.




Total Internal Reflection

Applications: Fiber optics

Binocular prisms




$n_1 = 1.6$

at ② $\theta_1 = 45°$

$n_1 \sin\theta_1 = 1.13$

① and ③: $\theta = 0$

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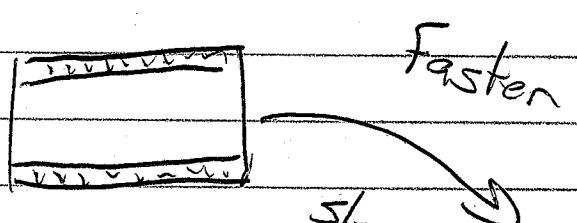
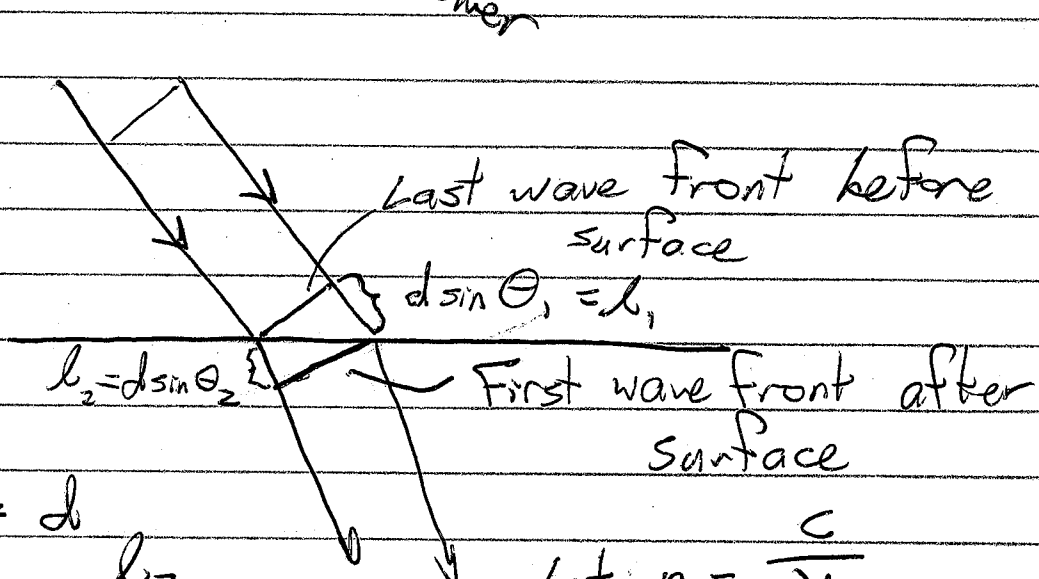
Why do waves refract?

- How does a bulldozer turn?




$d = d$

$$\frac{l_1}{\sin\theta_1} = \frac{l_2}{\sin\theta_2}$$

Let $n_1 = \frac{c}{v_1}$

$v_1 = c/n_1$

$$\frac{c\Delta t}{n_1 \sin\theta_1} = \frac{c\Delta t}{n_2 \sin\theta_2}$$

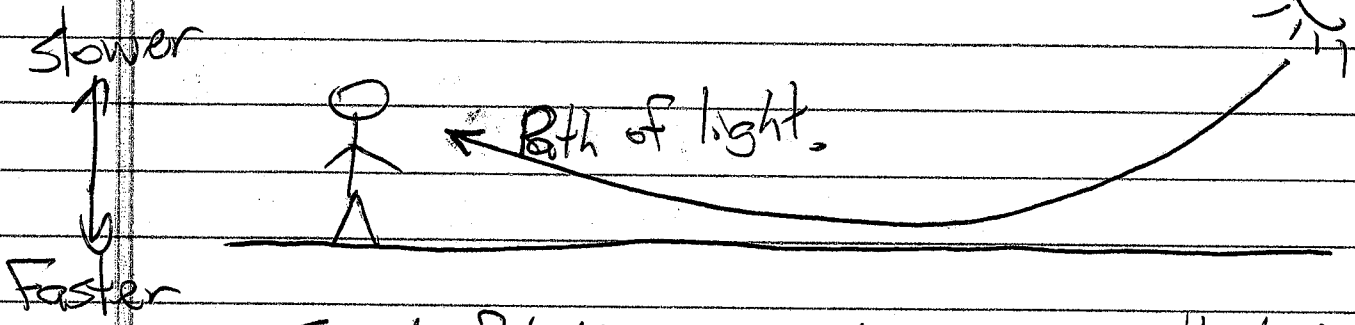
$n_1$ describes slowing of light

$l_1 = v_1 \Delta t = \frac{c\Delta t}{n_1}$

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

(3)

# Mirages: Refraction from a gradient.



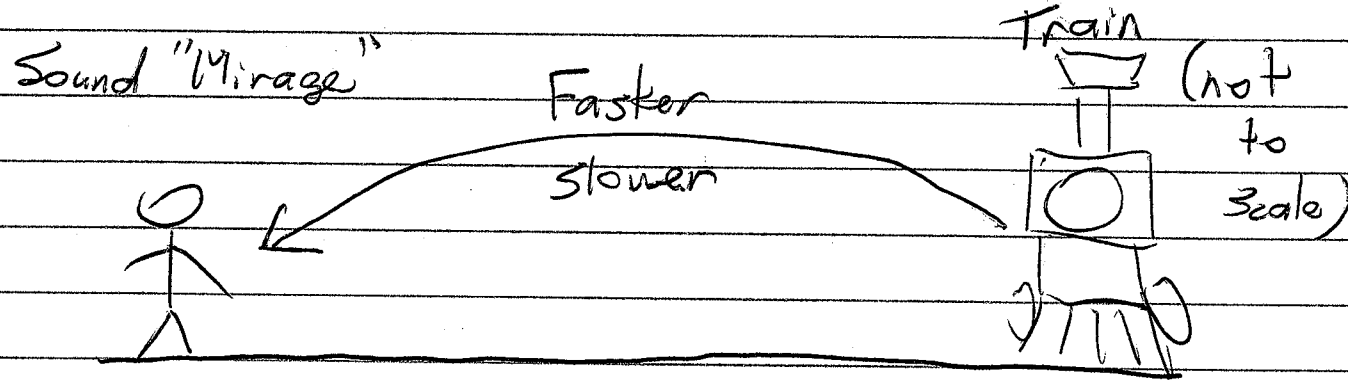

Speed of light in air decreases with high density.

$n_{air} \approx 1.0003$

$$PV = NRT$$

$$\frac{P}{T} = \frac{N}{V}R$$

High T → Low density
→ Fast Light
→ ~~High~~ Low index




Speed of sound increases with temperature.