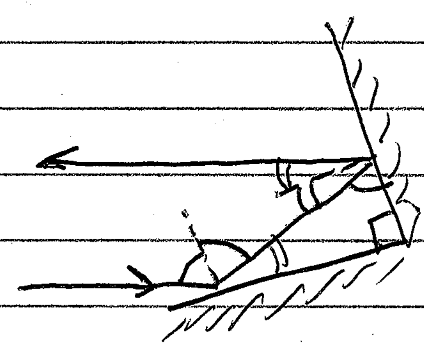
Phys 2426 2015-11-17 Lec 24

Optics – Controlling Waves

Geometric Optics – using two mechanisms:
- Reflection
- Refraction

Reflection: Bouncing of a wave off of a surface.
- Caused by oscillations of charges in the surface.
- Since light is transverse so the oscillations must be ⊥ to the reflected ray (at least partly)

Cubic Reflector



An incoming ray is retro-reflected toward the source.

- Vehicle markers
- Safety paint/tape
- Measuring Distances

Refractron - bending by a new material

n = index of refraction

$v = c/n$

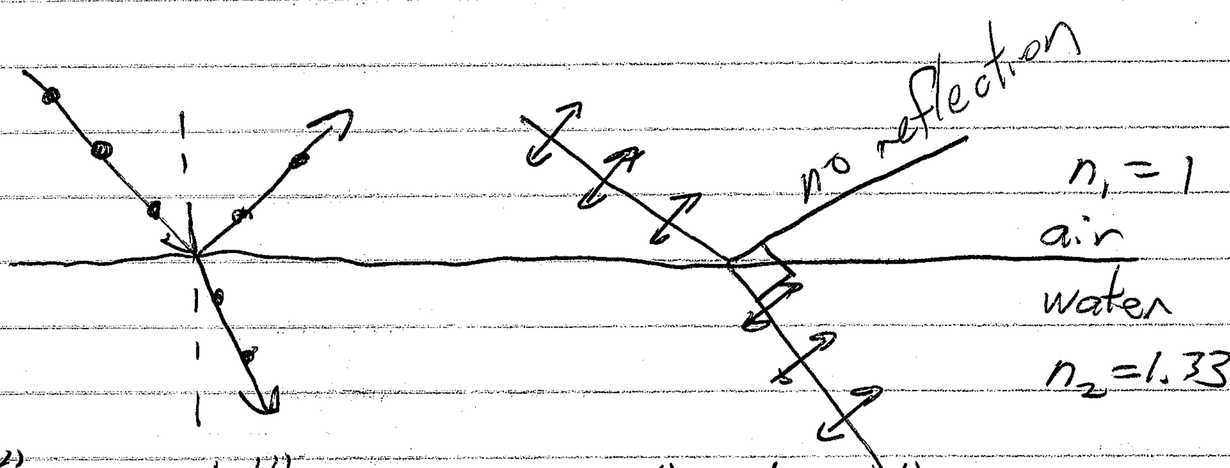
Snell's Law of Refraction

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

If n increases, θ decreases.
If $\theta_1 = 0$, $\theta_2 = 0$.
If n decreases $\sin(\theta)$ increases

- It's possible for $\sin(\theta_2)$ to be invalid.
- Then there is no refractron
- Total Internal Reflection

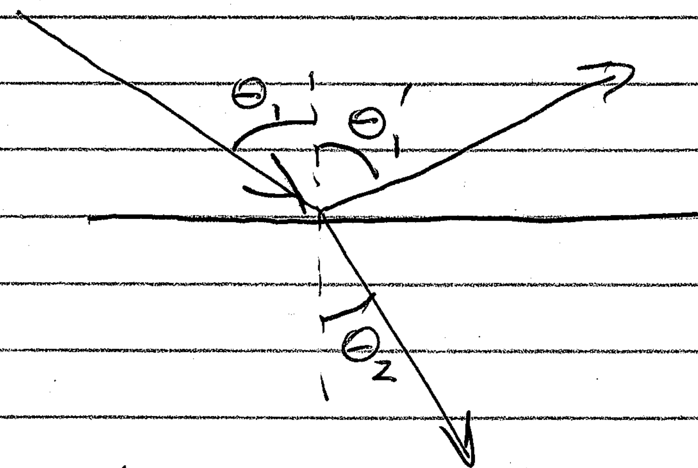
Polarization and Refraction



"Horizontal"
S-polarization
Oscillations in & out of page

"Vertical"
P-polarization
Oscillations in plane
Electrons not at all transverse to reflection.

(3)



If reflection ⊥ refraction,

$$\theta_1' + \theta_2 = 90^\circ$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$
$$= n_2 \sin(90^\circ - \theta_1)$$
$$= n_2 \cos(\theta_1)$$

$$\frac{\sin\theta_1}{\cos\theta_1} = \frac{n_2}{n_1}$$

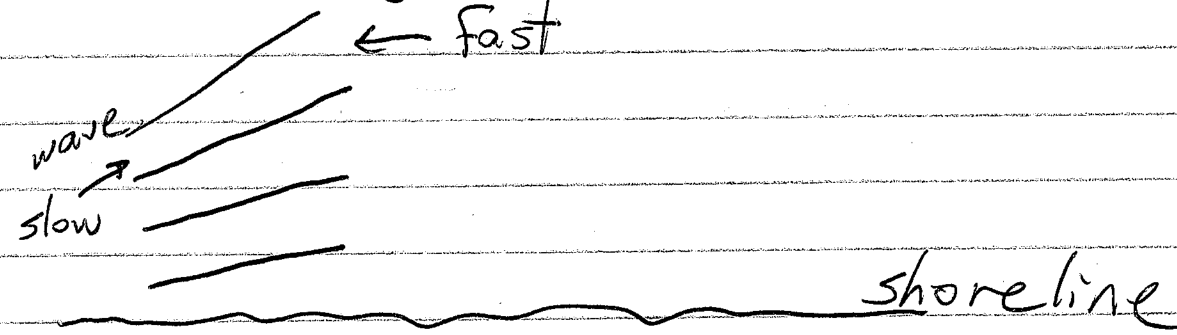
$$\tan\theta_1 = n_2/n_1$$ Brewster's Angle

All glare is horizontally polarized.

To find TIR, set $\sin\theta_2 = 1$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$
$$\sin\theta_1 = \frac{n_2}{n_1}$$ Critical Angle for TIR

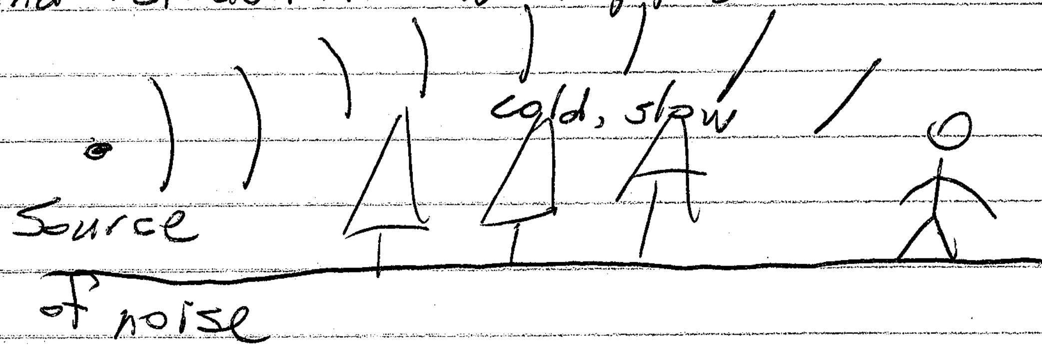
Refraction for gradual velocity changes



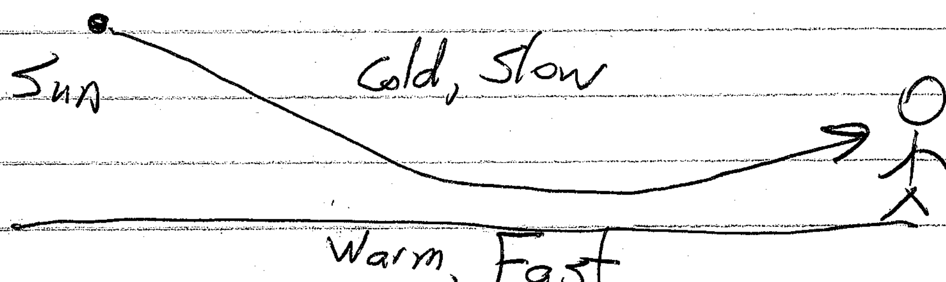
By the time they reach shore, most waves are moving ⊥ to shore.

- n increases (wave slows)
- θ decreases (ray closer to ⊥)

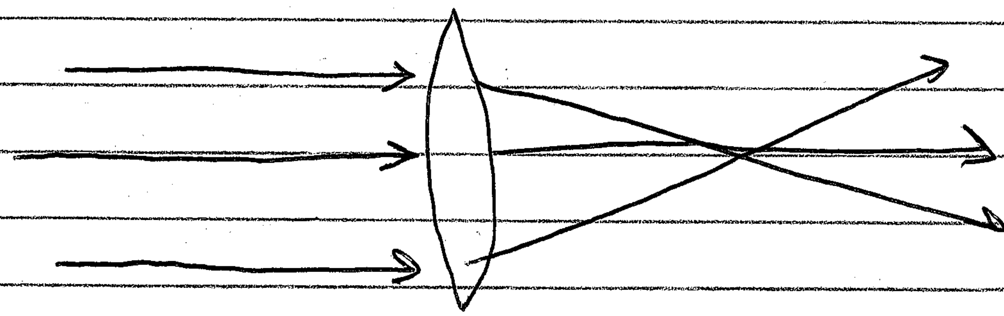
Sound refraction



Light Mirages



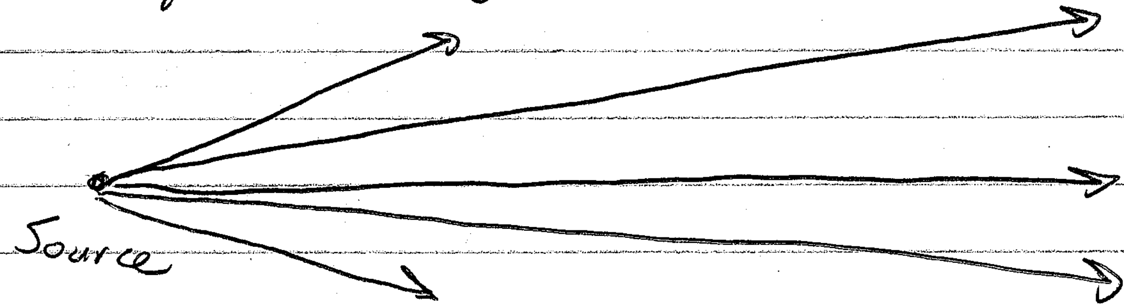
Lenses



Middle ray - lens is thick, so the time delay is the greatest.
Peripheral rays - lens is thin. less time delay.
Rays "repelled from fast region"
This is one way of explaining a converging lens.

Image Formation

We can only see diverging or parallel rays of light.



Could define diverging as $\frac{\Delta\theta}{\Delta y} \approx \frac{1}{p}$

Lens Equation:

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

p = obj distance
q = image position
f = lens focus

Note: If f is negative, q is ⊖

$$q = \left(\frac{1}{f} - \frac{1}{p}\right)^{-1}$$

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Farsightedness
- Can't see nearby obj
- Eye needs help converging
- Use a converging lens.

Nearsighted
- Can't see far
- Eye is converging too much.
- Use a diverging lens

When analyzing corrective lenses
- p = obj dist is pos ⊕
- q = image dist is ⊖