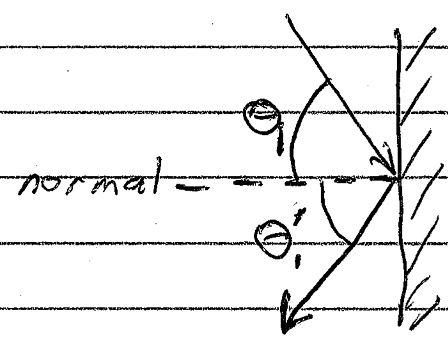
1 Phys 1402 2015-11-17 Lec 24

Optics - Controlling Waves

Generally, waves go in straight lines.
= Propagation Direction = Rays

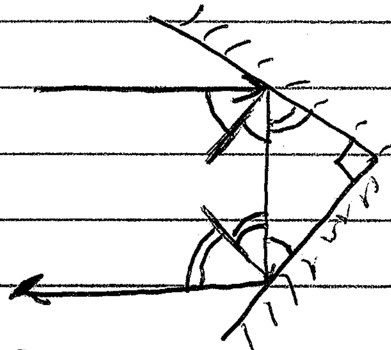
Geometric Optics -
- Reflection
- Refraction

Reflection - Bouncing off a surface.



θ_1 = incidence
θ_1' = reflection

Cubic Reflector



Final reflection goes back toward source

- Reflectors on vehicles
- Reflective Paint
- Moon Distance measurement

Refraction - bending of rays by a change in material

n = index of refraction

$$V = \frac{c}{n}$$

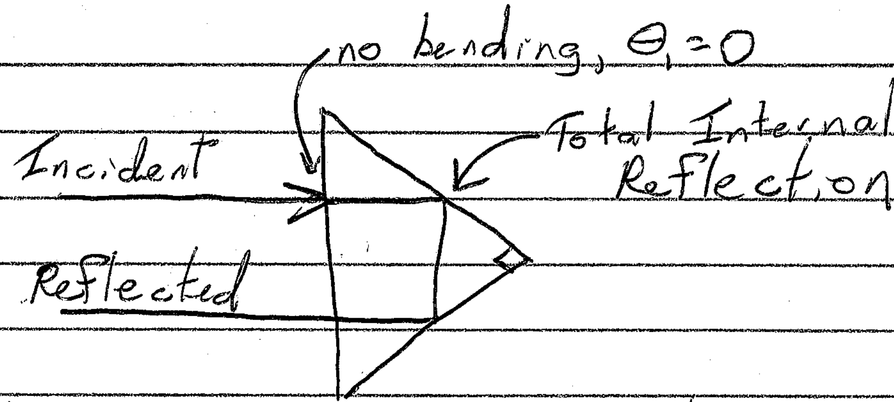
Snell's Law of Refraction

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

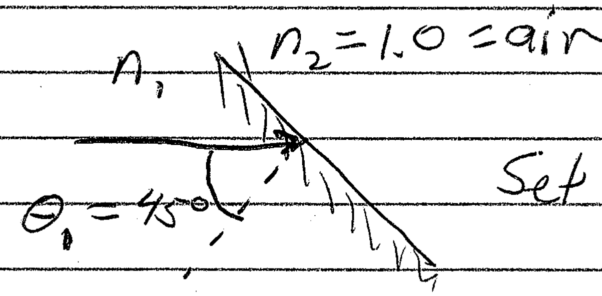
- n_1 ← First material
- θ_1 ← Angle of Incidence
- n_2 ← new material
- θ_2 ← angle of refraction

Notes: If n increases ($n_2 > n_1$)
- Wave Slows down
- θ decreases ($\theta_2 < \theta_1$)
  - i.e. new wave closer to normal
- There is always a valid θ_2.

If n decreases ($n_1 > n_2$)
- Wave speeds up.
- $\sin(\theta)$ increases
- $\sin(\theta_2)$ can be invalid (no θ_2)
  - This is Total Internal Reflection.



Glass prism in binoculars
What is the required n_{glass}?



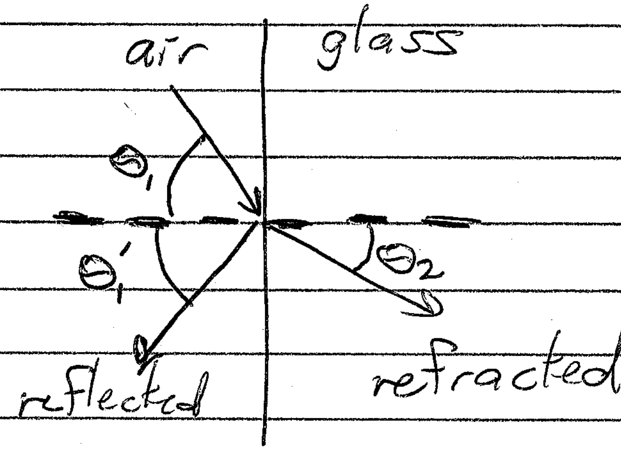
Set $\sin\theta_2 = 1$

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

$$n_{glass} \sin(45°) = (1.0)(1)$$

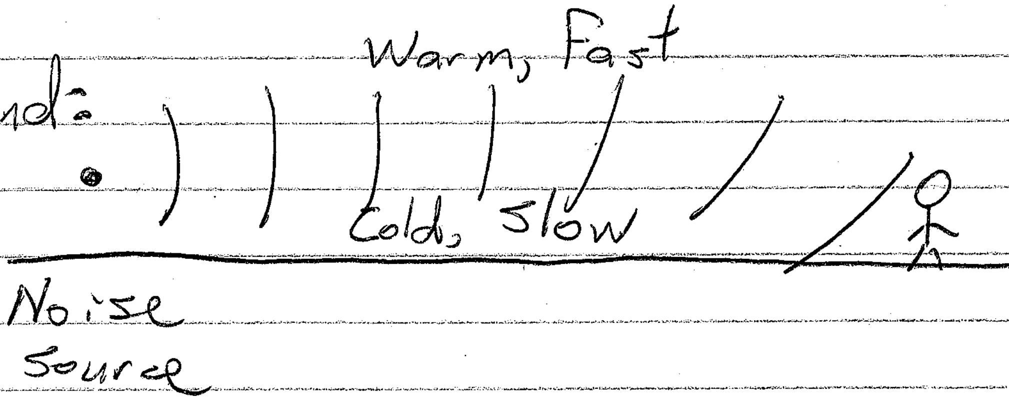
$$n_{glass} = \sqrt{2} = 1.4 \text{ minimum}$$

Generally

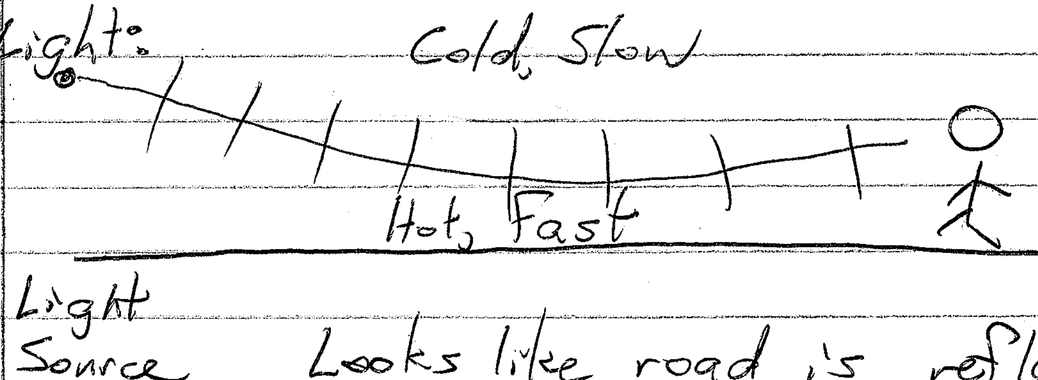


Refraction for light/sound travelling parallel to the interface.

Sound:

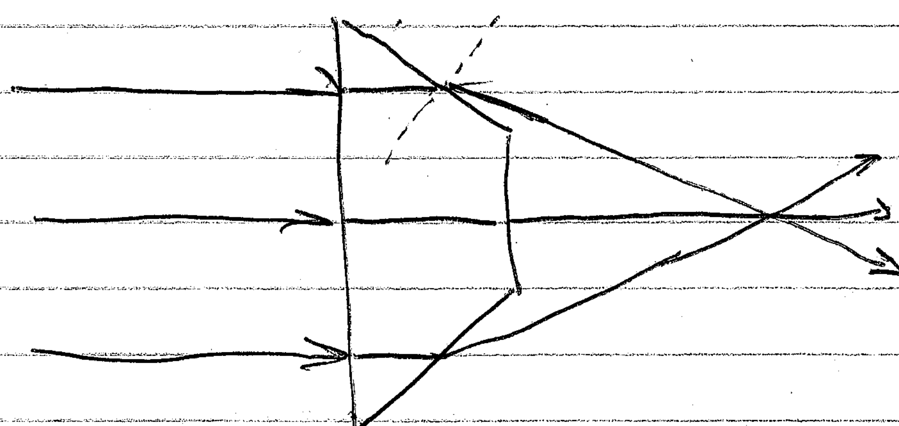


Light:



Looks like road is reflecting the light — mirage

Light



Compare to Lens

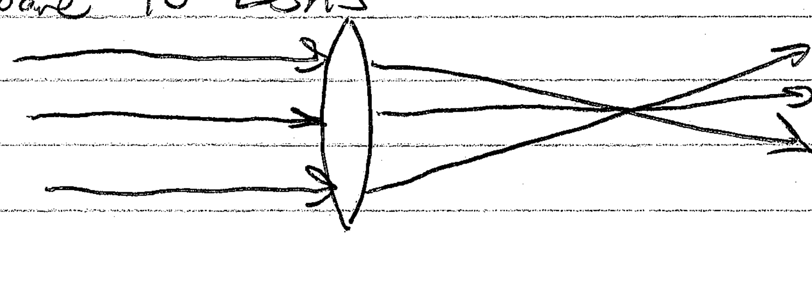
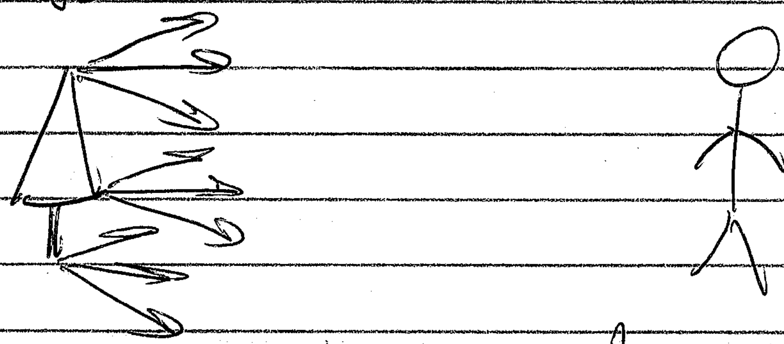
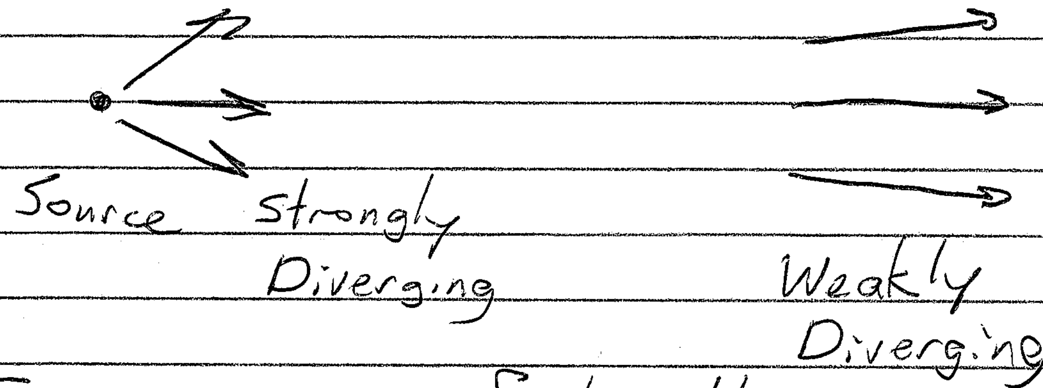


Image Formation



We see diverging rays.

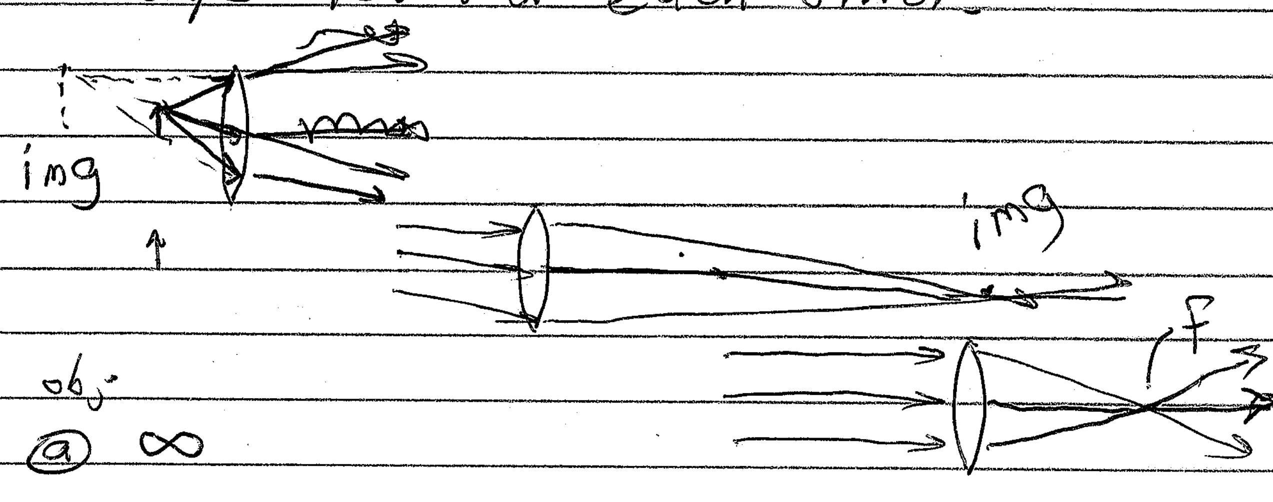
We only analyze point sources.



For a source @ infinity the rays are parallel.

We can't focus on converging rays.

A converging lens/mirror nudges rays toward each other.



(6)

Farsighted - can't see near

- can't see strongly diverging rays.
- Eye needs help converging an image.
- Use converging lens ($f = \oplus$ w)

Nearsighted - can't see far

- can't see parallel rays
- Eye is converging too much.
- Use diverging lens

Note: When analyzing the lens
p = obj pos is positive
q = image pos is negative