Lecture 25

Optical Instruments

- range of human eye can be extended by eyeglasses, microscopes, & telescopes.

- optical instruments consist of a sequence of lenses

Magnifying lens / glasses

- human eye can focus a sharp image on retina if object is located anywhere between ∞ & near point P_n
- If object moves closer to eye than near point,

then perceived image on retina becomes fuzzy

(show slides)

Angular magnification

$$m_\theta = \frac{\theta'}{\theta}$$

θ' ← new angle when object closer

θ ← angle @ near point

Approximate $\tan\theta \approx \theta$

& $\tan\theta' \approx \theta'$ for small angles

$\Rightarrow$ $\theta \approx \dfrac{h}{25\text{cm}}$ ← near point of eye (depends on person)

$\theta' \approx h/f$

$$\Rightarrow m_\theta \approx \frac{25\text{cm}}{f}$$

Compound Microscope consists of two lenses called objective + eyepiece

- objective produces a real image I inside focal point of eyepiece

- eyepiece forms a virtual final image seen by observer. (show slides)

<u>refracting telescope</u>

also has objective & eyepiece but w/ different dimensions

main difference w/ microscope is that 1st focal point of eyepiece be same as 2nd focal point of objective

Ch. 35

Interference

35-1 Light as a Wave

Previously, we were studying geometrical optics. Now we move on to study light as a wave.

- Huygen's principle allows us to figure out where a wave front will be in the future if we know its present position

pronounced "Hoy · gens"

Huygens's principle:

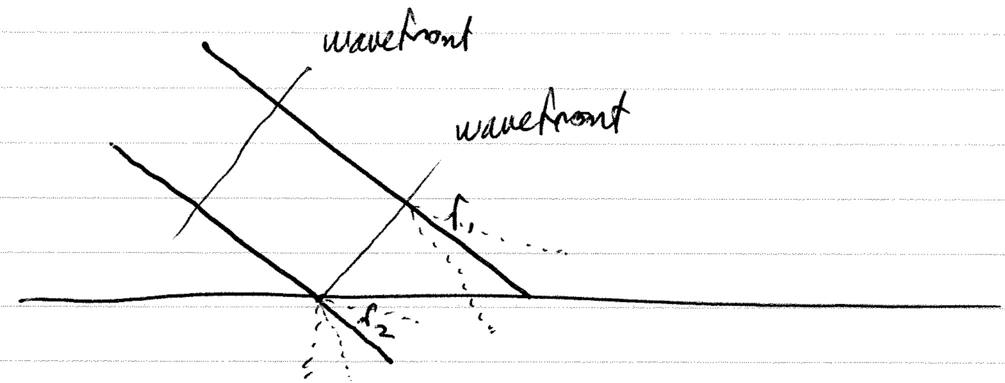
1) All points on a wavefront serve as point sources of spherical secondary wavelets.

2) After time t, new position of wave front will be that of a surface tangent to these secondary wavelets

(show slides for plane wave example)

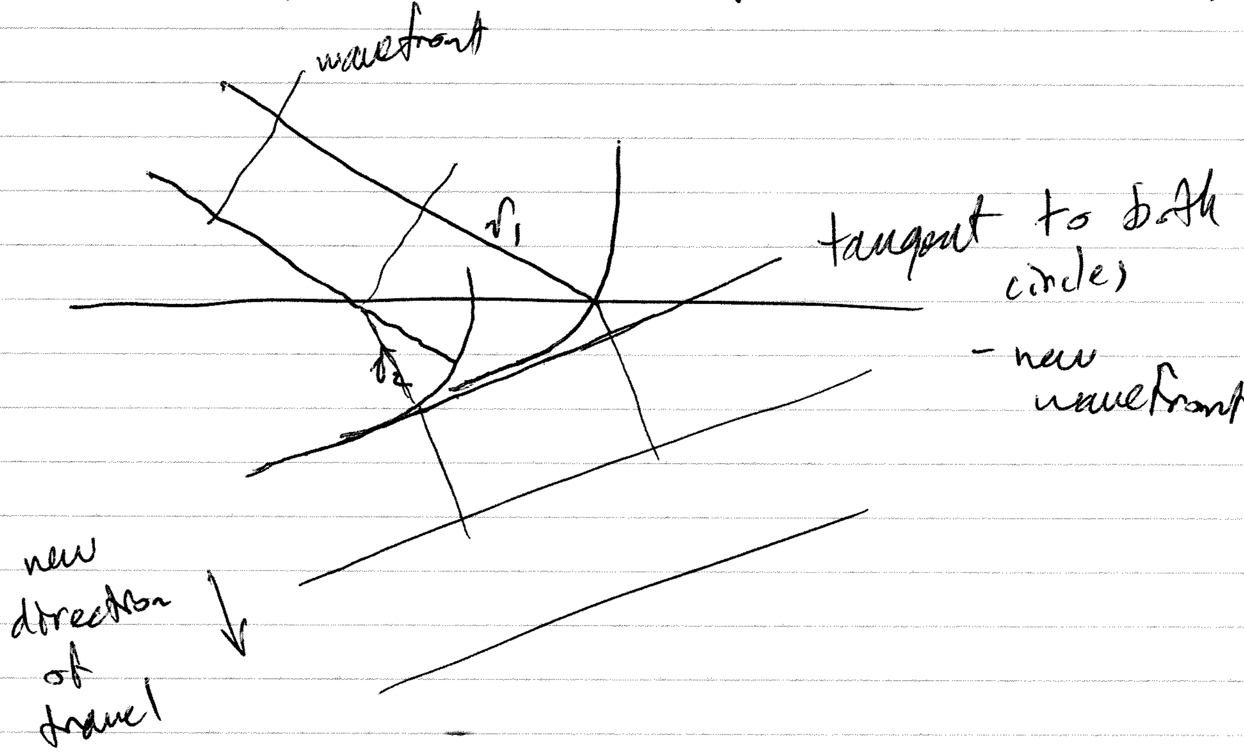
we can derive law of refraction using this theory (Huygens' principle)

- As plane wave is incident on glass, part of it slows down b/c speed of light is slower in glass.
- It thus travels less distance in same amount of time



distance traveled on top is r_1 & on bottom is r_2. Times passed are equal $\Rightarrow$ $\frac{r_1}{v_1} = \frac{r_2}{v_2} \Rightarrow \frac{r_1}{r_2} = \frac{v_1}{v_2}$

Now apply Huygens' principle to find new wave front (it is tangent to spherical wavelets)



(show slides)

Analyzing geometry for triangle hce:

$$\sin\theta_1 = \frac{r_1}{hc}$$

for triangle hcg:

$$\sin\theta_2 = \frac{r_2}{hc}$$

$$\Rightarrow \quad \frac{\lambda_1}{\sin\theta_1} = \frac{\lambda_2}{\sin\theta_2}$$

$$\Rightarrow \quad \frac{\lambda_1}{\lambda_2} = \frac{\sin\theta_1}{\sin\theta_2}$$

use $\frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$

$$\Rightarrow \quad \frac{v_1}{v_2} = \frac{\sin\theta_1}{\sin\theta_2}$$

use index of refraction $n = \frac{c}{v}$

$$\Rightarrow \quad \frac{n_2}{n_1} = \frac{\sin\theta_1}{\sin\theta_2}$$

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

Snell's law of refraction