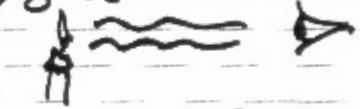
What is Light?

Newton: a particle

Huygens: a wave



→ interference

Maxwell
→ a form of EM wave

... but ...

- photoelectric effect

K.E. of emitted e's ≠ f(light intensity) (inconsistent w/ waves)

- Quantum
$E = hf$



Geom. Optics

- ray approximation

=

⊥ to wave fronts

- light
  - straight path in uniform medium
  - change direction when hit new medium
    - or nonuniformities
  - → apertures

$\lambda \ll d$ $\lambda \sim d$ $\lambda \gg d$

assume for Geom. optics

## Law of Reflection

known to Euclid


mirror surface

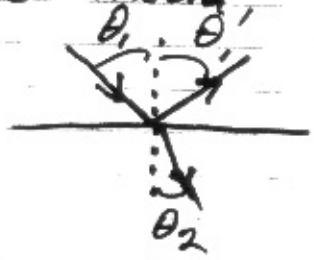
$\theta_1$ = angle of incidence
$\theta_1'$ = angle of reflection

$$\boxed{\theta_1 = \theta_1'}$$

13 09/10 09 — 21, p1

## Refraction

- 2 transparent media
- incident ray
  → part of energy in ray which penetrates medium #2




- → speed of light in medium
  → absorption + radiation "slows light down"
- relationship between velocities + angles

$$\frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1} = \text{constant}$$

→ when speed ↓ at boundary
→ angle closer to normal is output

## Index of Refraction

→ by definition

$$n \equiv \frac{c\ (\text{vacuum})}{v\ (\text{medium})}$$

→ always $> 1$ ($v < c$)

- $f_1 = f_2$ but $\lambda_1 \neq \lambda_2$
  - ↳ need to have at boundary → or pile up energy
- since $v_1 = f\lambda_1$
  - if $v_1 \neq v_2$, $\lambda_1 \neq \lambda_2$

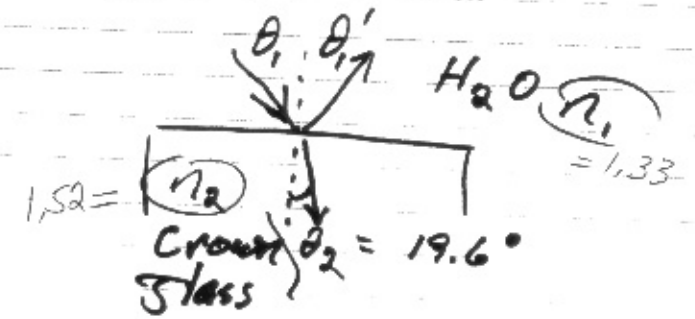
$$\frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2} = \frac{c/n_1}{c/n_2} = \frac{n_2}{n_1}$$

$$\therefore \boxed{n_1 \sin\theta_1 = n_2 \sin\theta_2}$$

Snell's law of refraction



## Prob 14




$$\sin\theta_2 = \frac{n_1}{n_2}\sin\theta_1 \quad \text{(Snell's law)}$$

$$\theta_2 = \sin^{-1}\left(\frac{n_1}{n_2}\sin\theta_1\right)$$

then $\theta_1' = \theta_1$ (law of refl.)

Huygen's Principle

- all points on wave front
  - sources of production of spherical secondary waves

→ can be used to derive

- law of reflection

$$\theta_1 = \theta_1'$$

- Snell's Law

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

- Look at Section 35.6