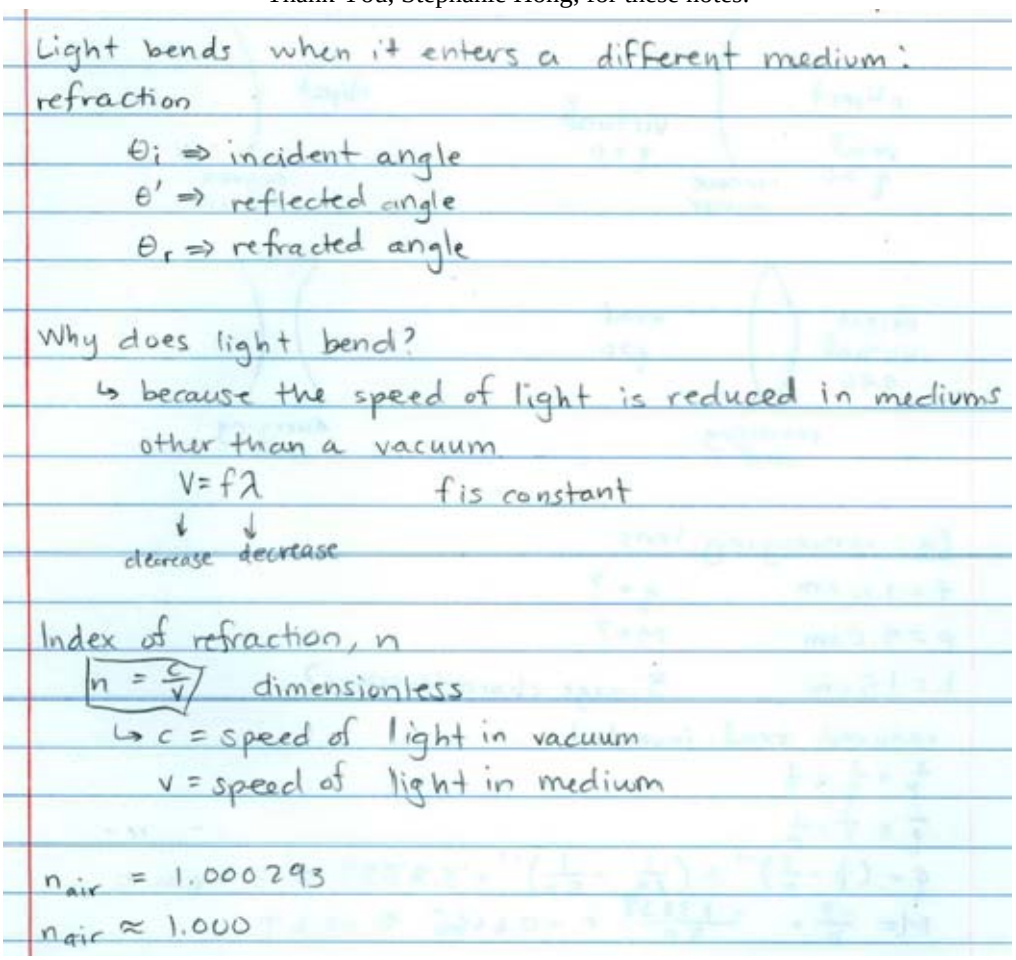
Video Lecture #1 – Chapter 15.1 - Introduction to the Refraction of Light and the Index of Refraction

Thank You, Stephanie Hong, for these notes.



Light bends when it enters a different medium: refraction

$\theta_i \Rightarrow$ incident angle

$\theta' \Rightarrow$ reflected angle

$\theta_r \Rightarrow$ refracted angle

Why does light bend?

↳ because the speed of light is reduced in mediums other than a vacuum

$V = f\lambda$ f is constant

↓ ↓

decrease decrease

Index of refraction, n

$\boxed{n = \frac{c}{v}}$ dimensionless

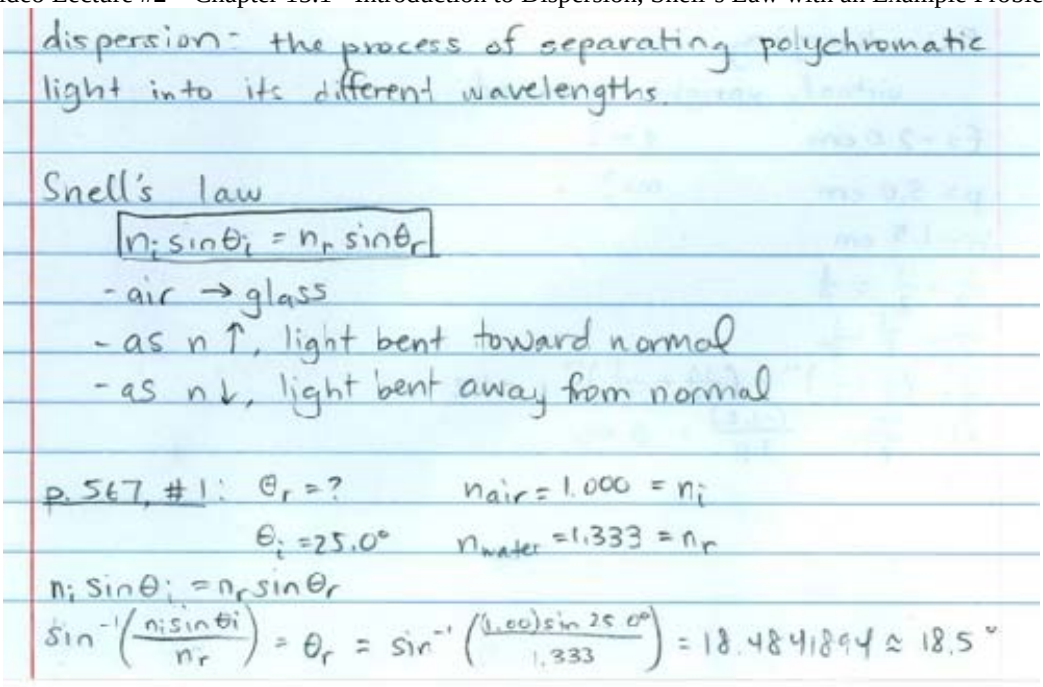
↳ c = speed of light in vacuum

v = speed of light in medium

$n_{air} = 1.000293$

$n_{air} \approx 1.000$

Video Lecture #2 – Chapter 15.1 - Introduction to Dispersion, Snell's Law with an Example Problem



dispersion: the process of separating polychromatic light into its different wavelengths.

Snell's law

$\boxed{n_i \sin\theta_i = n_r \sin\theta_r}$

- air → glass
- as n ↑, light bent toward normal
- as n ↓, light bent away from normal

p. 567, #1: $\theta_r = ?$ $n_{air} = 1.000 = n_i$

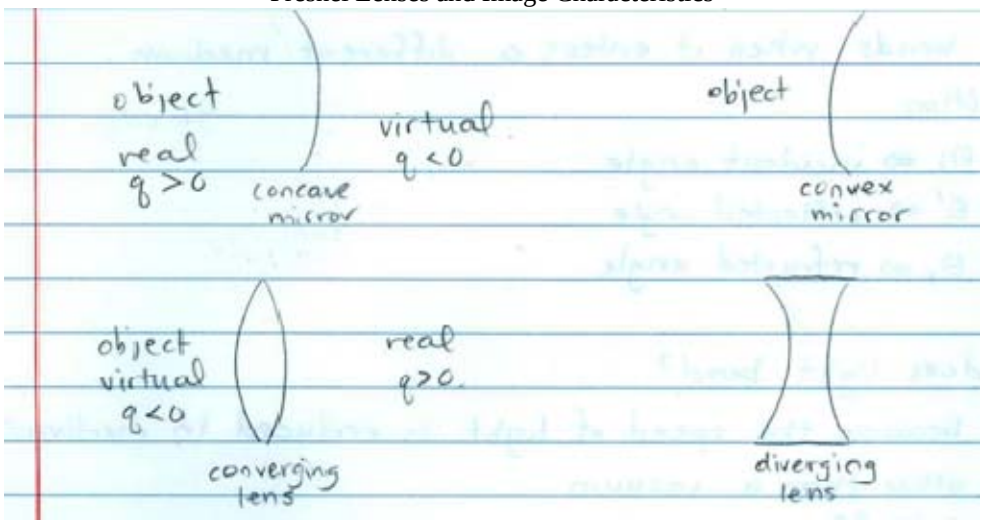
$\theta_i = 25.0°$ $n_{water} = 1.333 = n_r$

$n_i \sin\theta_i = n_r \sin\theta_r$

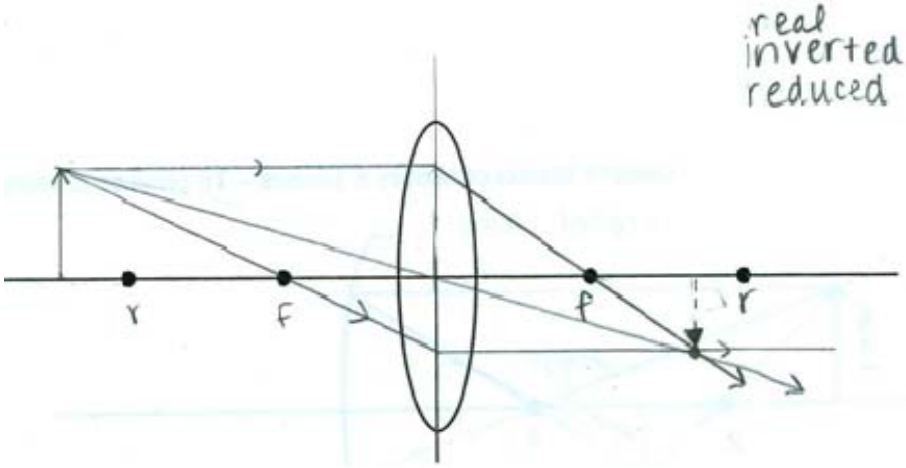
$\sin^{-1}\left(\frac{n_i \sin\theta_i}{n_r}\right) = \theta_r = \sin^{-1}\left(\frac{(1.00)\sin 25.0°}{1.333}\right) = 18.4841894 \approx 18.5°$

Video Lecture #3 – Chapter 15.1 - Understanding how a Mirage Works - Refraction of Light (no lecture notes)

Video Lecture #4 – Chapter 15.2 - Introduction to Converging Lenses (or Bi-Convex), Fresnel Lenses and Image Characteristics



Video Lecture #5 – Chapter 15.2 - Example - Learning how to Draw a Ray Diagram of a Converging Lens (or Bi-Convex) includes the Math



Ex: converging lens

$f = 2.0$ cm $q = ?$

$p = 5.0$ cm $M = ?$

$h = 1.5$ cm 3 image characteristics?

reduced, real, inverted

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

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

$q = \left(\frac{1}{f} - \frac{1}{p}\right)^{-1} = \left(\frac{1}{2.0} - \frac{1}{5.0}\right)^{-1} = 3.333\overline{3} \approx 3.3$ cm

$M = \frac{-q}{p} = \frac{-3.333\overline{3}}{5.0} = -0.666\overline{6} \approx -0.67$

Video Lecture #6 – Chapter 15.2 - Example - Learning how to Draw a Ray Diagram of a Diverging Lens (or Bi-Concave) includes the Math

Ex: diverging lens

virtual, upright, reduced

$f = -2.0$ cm $q = ?$

$p = 3.0$ cm $m = ?$

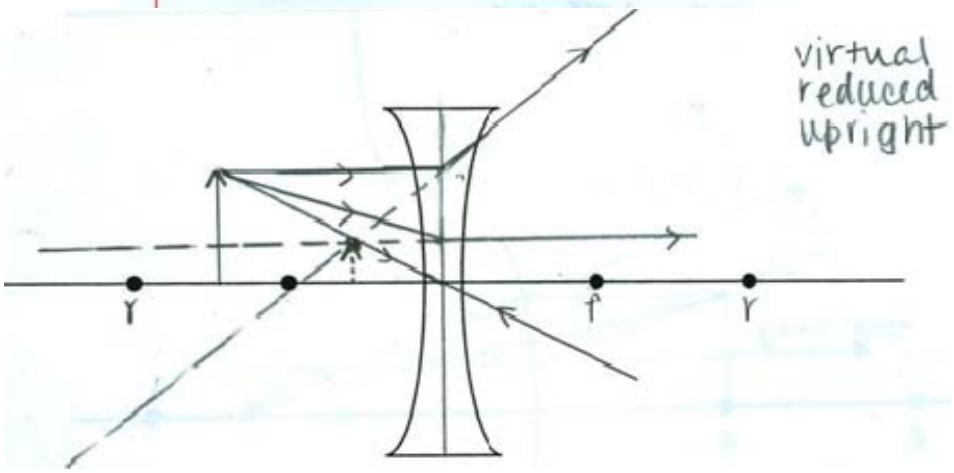
$h = 1.5$ cm

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

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

$q = \left(\frac{1}{f} - \frac{1}{p}\right)^{-1} = \left(\frac{1}{-2.0} - \frac{1}{3.0}\right)^{-1} = -1.2$ cm

$M = \frac{-q}{p} = \frac{-(-1.2)}{3.0} = 0.40$



Video Lecture #7 – Chapter 15.2 - A Basic Explanation of the Optics of the Human Eye (no lecture notes)

Total Internal Reflection

θ_c = critical angle

↳ the minimum incident angle at which all incident light will be totally internally reflected.

- if $\theta_i \geq \theta_c \Rightarrow$ total internal reflection
- $n_i \sin\theta_i = n_r \sin\theta_r$
- $\theta_i = \theta_c$ when $\theta_r = 90°$
- $n_i \sin\theta_c = n_r \sin(90°)$ → 1
- $\sin\theta_c = \frac{n_r}{n_i}$

$1 \geq \sin\theta_c = \frac{n_r}{n_i}$

$1 \geq \frac{n_r}{n_i}$

$n_i \geq n_r$

Ex.

$n_{air} = 1.000$

$n_{block} = 2.50$

$\theta_i = 0°$

$n_i \sin\theta_i = n_r \sin\theta_r$

air → block

incident → refracting

$(1)\sin(0) = (2.5)\sin\theta_r$

$0 = 2.5 \sin\theta_r$

$0 = \sin\theta_r$

$\theta_r = \sin^{-1} 0 = 0$

$\theta_1 = 30° \Rightarrow \theta_r = ?$

$n_i \sin\theta_i = n_r \sin\theta_r$

block → air

incident → refracting

$(2.5)\sin 30° = (1)\sin\theta_r$

$1.25 = \sin\theta_r$

$\theta_r = \sin^{-1} 1.25$ = impossible

totally internally reflected

$\sin\theta_c = \frac{n_r}{n_i}$

$\theta_c = \sin^{-1}\left(\frac{n_r}{n_i}\right) = \sin^{-1}\left(\frac{1}{2.5}\right)$

$\theta_c = 23.578°$

$\theta_1 = \theta_2 = \theta_3 = 30° > \theta_c$

totally internally reflected

$\theta_4 = 30°$

$\theta_5 = 60° > \theta_c$

totally internally reflected

$\theta_6 = 60°$

$\theta_7 = 30°$

$\theta_i = 0° < \theta_c$

refraction!!

$\theta_r = 0$