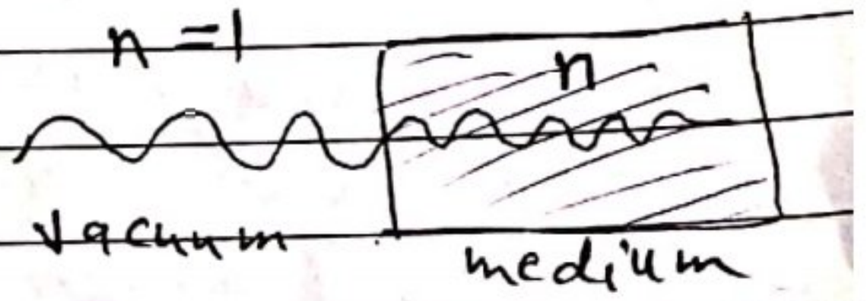
Chapter 23

Wave properties of Light

□ The index of refraction



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

c: speed of light in vacuum

v: " " " " " medium

□ frequency and wavelength

if the light has a frequency f and wavelength λ then

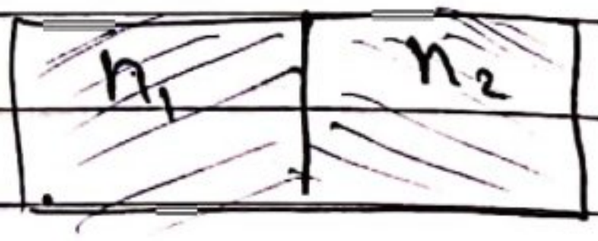
$$f = \frac{v}{\lambda}$$

But $c = nv = \text{constant}$

that is

$$n_1 v_1 = n_2 v_2$$

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



Example: Green light with a wavelength of 5×10^{-7} m in vacuum enter a glass plate with refractive index 1.5

a) What is the velocity of light in the glass

b) " " " wavelength " " " " " "

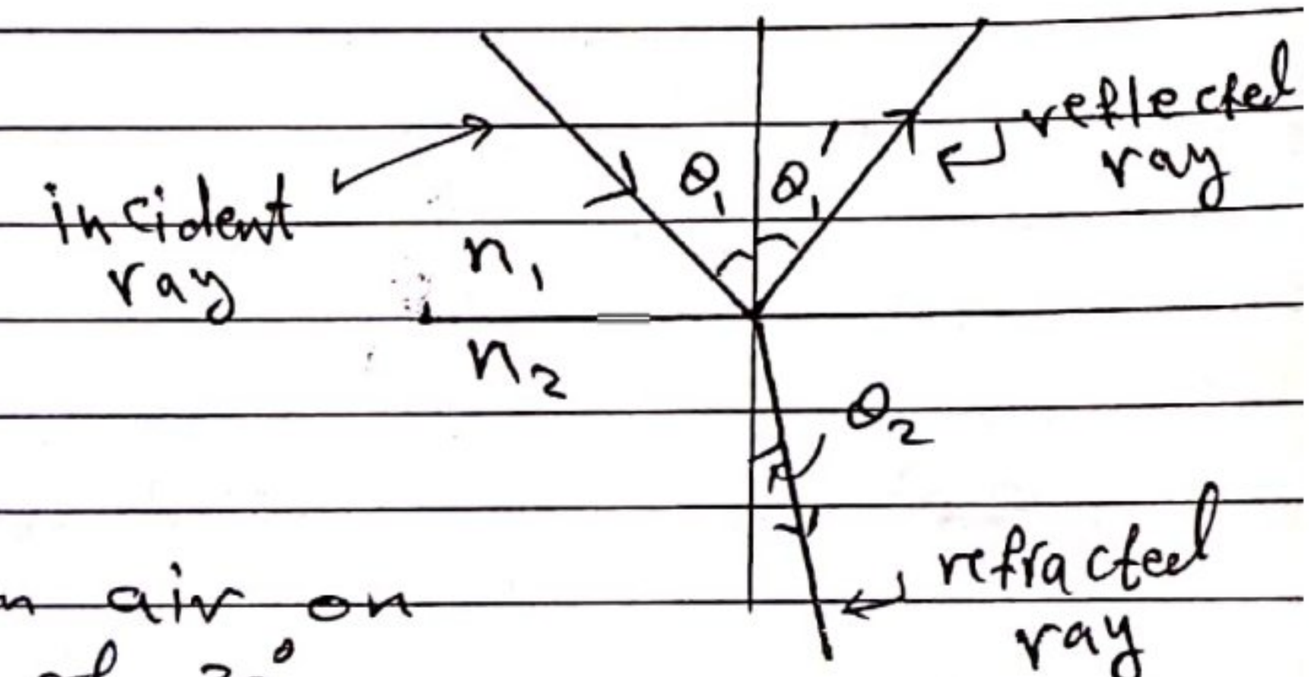
a) $v = \frac{c}{n} = \frac{3 \times 10^8}{1.5} = 2 \times 10^8$ m/s

b) $\lambda_2 = \lambda_1 \frac{n_1}{n_2} = (5 \times 10^{-7}) \frac{1}{1.5} = 3.33 \times 10^{-7}$ m

☐ Snell's law

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

$$\theta_1 = \theta_1'$$



Example:

Light is incident from air on water at an angle of 30°. Part of the light is reflected and part is refracted. Find the angles of the two beams.

$\theta_1 = \theta_1' = 30°$

$n_1 = 1$

$n_2 = 1.33$

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

$(1)(\sin 30) = (1.33)(\sin\theta_2)$

$\theta_2 = 22°$

Chapter 24
Mirrors and Lenses

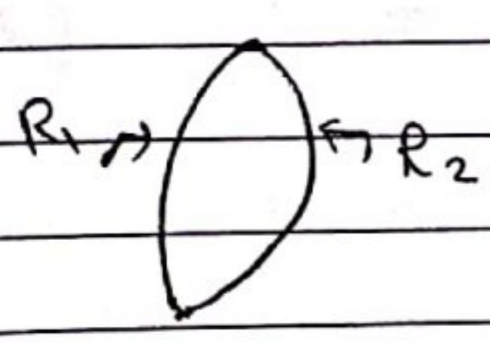
□ Mirrors

images in mirrors are:
virtual, and erect

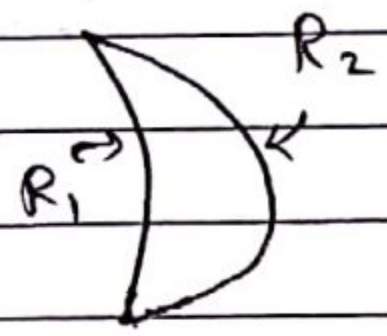
□ Lenses

conventions in characterizing Lens surfaces

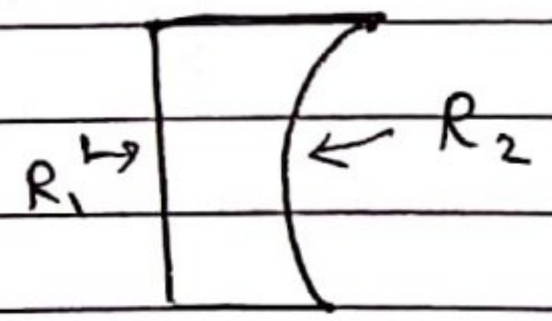
1) A convex surface has a positive radius of curvature
2) A concave " " a negative " " "
3) A plane " " an infinite " " "



R_1: positive
R_2: positive
two convex surfaces



R_1: negative
R_2: positive
one convex and the other concave



R_1: infinite
R_2: negative
plane surface and concave one

□ Focal Length

the focal length of a lens with index n in a medium of index 1 is

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

Example:

Find the focal length of lenses made from glass with a refractive index of 1.5 if the two convex surfaces with radii of curvature a) 0.1 m and 0.2 m b) one plane surface and one concave surface of radius 4 m

a) $\frac{1}{f} = (1.5-1)\left[\frac{1}{0.1} + \frac{1}{0.2}\right] = \frac{1}{0.133}$

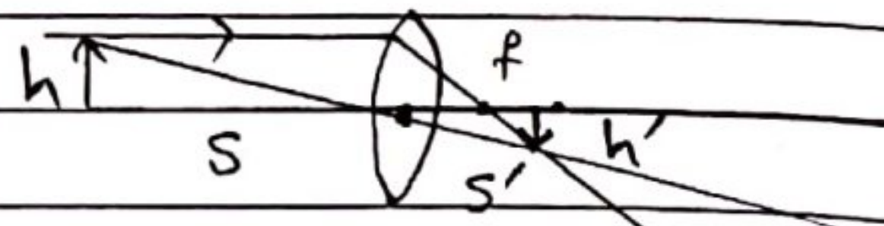
$f = 0.133 \text{ m}$

b) $\frac{1}{f} = (1.5-1)\left[\frac{1}{\infty} + \frac{1}{-4}\right] = \frac{-1}{8}$

$f = -8 \text{ m}$

☐ Thin Lens formula

$$\frac{1}{f} = \frac{1}{s} + \frac{1}{s'}$$



f: focal length $\begin{cases} + \text{ convex} \\ - \text{ concave} \end{cases}$

s: distance of the object from the lens

s': " " " image " " "

Example: A lens has a focal length of 0.1 m. Find the image distances when the object distance is a) 0.5 m b) 0.08 m

a) $\frac{1}{s'} = \frac{1}{f} - \frac{1}{s} = \frac{1}{0.1} - \frac{1}{0.5} \Rightarrow s' = 0.125 \text{ m}$

b) $\frac{1}{s'} = \frac{1}{f} - \frac{1}{s} = \frac{1}{0.1} - \frac{1}{0.08} \Rightarrow s' = -0.4 \text{ m}$

Note: s is positive for real object

s' " " " " image

Chapter 30
Nuclear Physics

A nucleus is specified by its atomic number Z and its mass number A.

The standard notation for nuclei is

$$^{A}_{Z}X$$

where

Z is the number of protons in the nucleus
A is the number of nucleons (protons + neutrons)

A − Z is the number of neutrons

Chapter 31
Radioactivity

□ Radioactivity: is the process in which unstable atomic nuclei spontaneously decompose to form nuclei with a higher stability by the release of energetic sub atomic particles.

□ Types of Radiation

There are 3 main types of radiations:

D Alpha particles (α)
i) they are helium nuclei ^4_2He
ii) they are positively charged protons
iii) low speed $v \simeq 0.05c$
iv) they have greatest ionization but least penetration

2) Beta particles (β)
i) they are negatively charged particles ($\bar{e}$)
ii) they have high speed $v \simeq 0.9c$
iii) less ionization and greater penentration than α-particles

3) Gamma rays (γ)
i) they are electromagnetic waves of very short wavelength and high frequency
ii) they have no electric charge
iii) they are the least ionization and the greatest penetration
iv) they travels with speed of light $v=c$