CHAPTER 10: THE HUMAN EYE AND THE COLOURFUL WORLD

Introduction

Light helps us see objects around us. The human eye is a natural optical instrument that works similarly to a camera. This chapter explains:

- Structure and functioning of the human eye
- Defects of vision and their correction
- Refraction through prism
- Dispersion and spectrum
- Atmospheric refraction
- Scattering of light and its applications

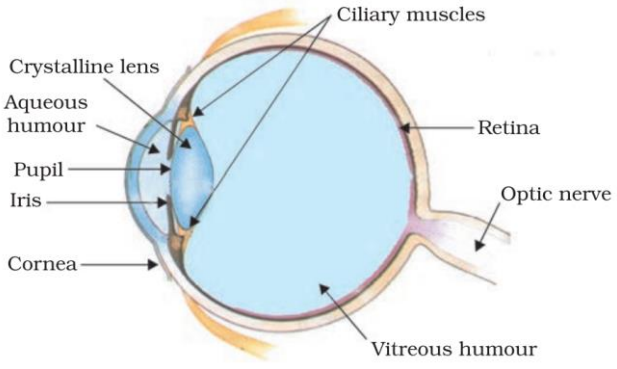
The Human Eye

Structure of the Human Eye

The human eye is a spherical organ (diameter ≈ 2.3 cm).

Main Parts of the Eye:

1. **Cornea**
    - Transparent outer layer
    - Light enters through it
    - Most refraction occurs here
2. **Iris**
    - Colored part of the eye
    - Controls size of pupil
3. **Pupil**
    - Opening through which light enters
    - Regulates amount of light
4. **Eye Lens**
    - Transparent, flexible



- Focuses light on retina

5. **Ciliary Muscles**
    - Control shape of lens
6. **Retina**
    - Light-sensitive screen
    - Image is formed here
7. **Optic Nerve**
    - Sends signals to brain

Working of the Eye

- Light enters through cornea
- Gets refracted and passes through pupil
- Lens focuses light on retina
- Image formed is **real, inverted and diminished**
- Brain interprets it as erect

Power of Accommodation

The ability of the eye lens to adjust its focal length to see objects at different distances clearly.

How it Works:

Object Distance	Action of Ciliary Muscles	Lens Shape	Focal Length
Distant	Relax	Thin	Increases
Near	Contract	Thick	Decreases

Important Terms

- **Near Point:** Minimum distance for clear vision = **25 cm**
- **Far Point:** Maximum distance = **Infinity (∞)**

Cataract

- Lens becomes cloudy
- Causes blurred vision
- Treated by surgery

Defects of Vision and Their Correction Myopia (Near-Sightedness)

Person can see near objects clearly but not distant objects.

Causes:

- Eyeball elongated
- Lens too curved

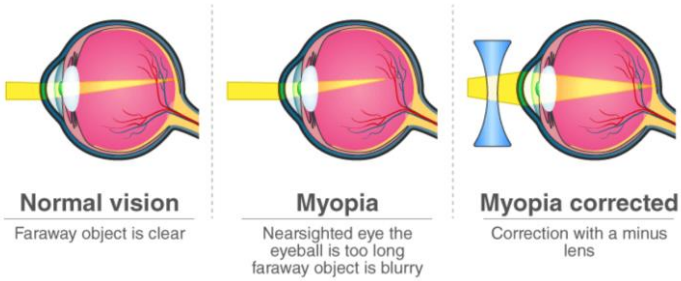


Image Formation:

Image forms **in front of retina**

Correction:

- Use **Concave Lens**

Hypermetropia (Far-Sightedness)

Person can see distant objects clearly but not near objects.

Causes:

- Eyeball too small
- Lens has less curvature

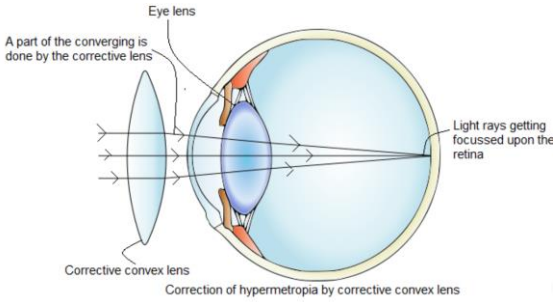


Image Formation:

Image forms **behind retina**

Correction:

- Use **Convex Lens**

Presbyopia

Age-related defect where near vision becomes difficult.

Causes:

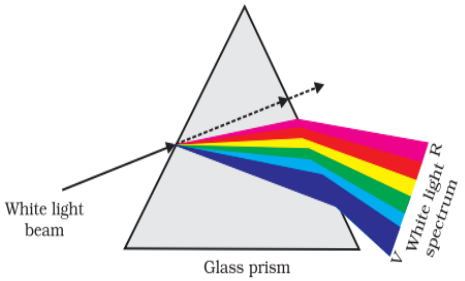
- Weak ciliary muscles
- Less flexible lens

Correction:

- Bifocal lenses:
    - Upper part: Concave (distance)
    - Lower part: Convex (near)

Refraction of Light Through a Prism

- A triangular glass object
- Has two refracting surfaces



Refraction Process

- Light bends **towards normal** (air → glass)
- Light bends **away from normal** (glass → air)

Angle of Deviation

Definition:
Angle between incident ray and emergent ray.

- Due to prism shape, emergent ray is not parallel
- This bending is called **deviation**

Dispersion of Light

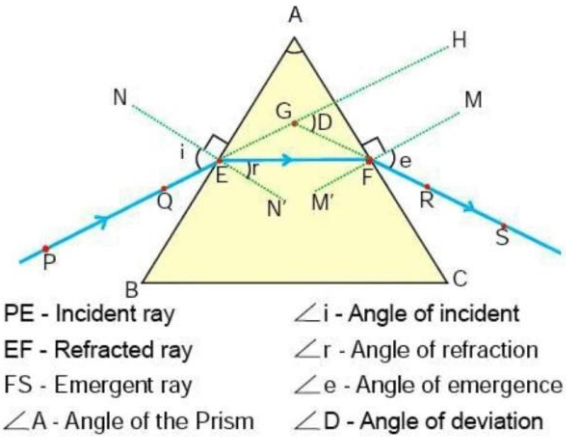
Splitting of white light into its component colours is called **dispersion**.

Spectrum

The band of colours obtained is called **spectrum**.

Order of Colours (VIBGYOR):

- Violet
- Indigo
- Blue
- Green
- Yellow
- Orange
- Red



Reason of Dispersion

- Different colours have different wavelengths
- Each bends differently:
    - Red → least deviation
    - Violet → maximum deviation

Recombination of Light

- Using second prism, colours recombine
- Forms **white light again**

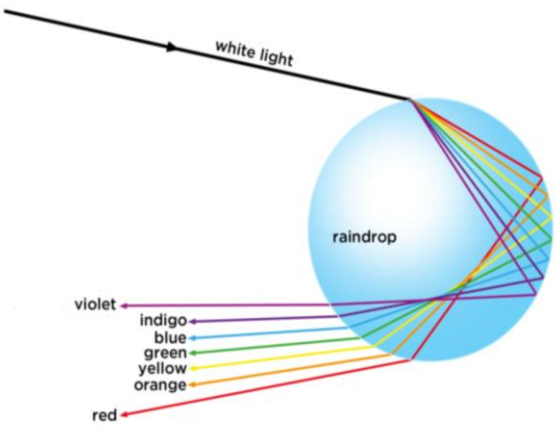
Rainbow Formation

Conditions:

- Sun behind observer
- Water droplets in atmosphere

Process:

1. Refraction
2. Dispersion
3. Internal reflection
4. Refraction again



Atmospheric Refraction

Definition:

Refraction of light by Earth's atmosphere.

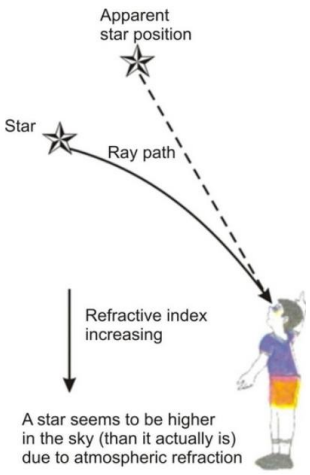
Twinkling of Stars

Reason:

- Continuous refraction by varying air density
- Light path keeps changing

Why Stars Twinkle:

- They are point sources



Why Planets Don’t Twinkle:

- They are extended sources

Advance Sunrise and Delayed Sunset

- Sun visible **2 minutes early**
- Visible **2 minutes late after sunset**
- Due to bending of light

Scattering of Light

Definition:

Deviation of light from its straight path due to particles.

Tyndall Effect

Definition:

Scattering of light by colloidal particles.

Examples:

- Sunlight in dusty room
- Light through fog

Blue Colour of Sky

Reason:

- Air particles scatter shorter wavelength (blue) more
- Hence sky appears blue

Important Application

Why Danger Signals are Red?

- Red light scatters least
- Visible from long distance

Key Formulas

- Power of lens:
  P = 1/f (in meters)
- Unit: **Dioptre (D)**

Important Exam Points

- Retina forms **real & inverted image**
- Brain makes image **erect**
- Near point = **25 cm**
- Myopia → Concave lens
- Hypermetropia → Convex lens
- Dispersion → splitting of light
- Blue sky → scattering