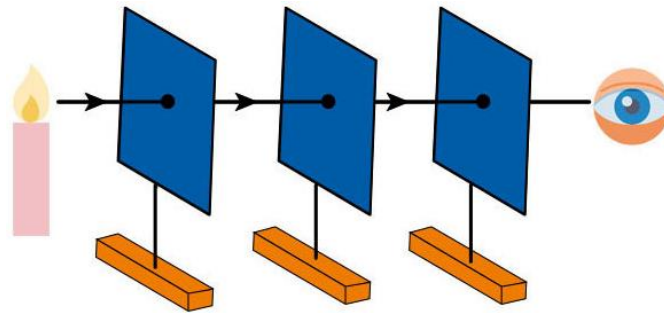# Chapter – 13: Light

Light

- Form of energy – helps us to see objects around us
- Light bounces off or gets reflected off of objects – reaches our eye – we see them
- Characteristics of light –
    o Rectilinear propagation –
        ▪ Light travels in straight line
        ▪ Light strikes object – depending on object's properties – pass through them or reflect back – does not bend

    o Reflection –
        ▪ Light strikes opaque object – bounces off or reflected off
        ▪ Reflected light – reach our eye – image formed

Laws of reflection

- Light's behavior – predictable
- Phenomenon (property) of reflection – follow some rules – laws of reflection
    o **First law -**
        ▪ Angle of incidence = angle of reflection
        ▪ ∠i = ∠r
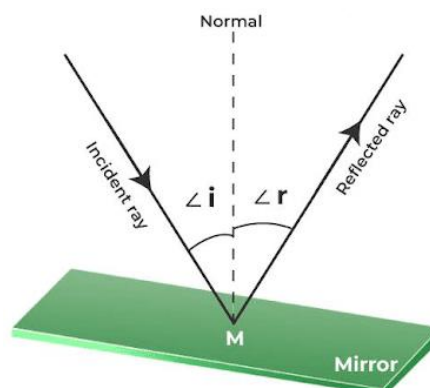
   ▪ Incident ray –
            • Ray of light from source to object
        ▪ Reflected ray –
            • Ray of light away from object
        ▪ Normal –
            • Imaginary line – perpendicular to surface – point of reflection

- Angle of incidence –
  - Angle between incident ray and normal - $\angle i$
- Angle of reflection –
  - Angle between normal and reflected ray - $\angle r$
- **Second law –**
 - Incident ray, reflected ray, normal – all in same plane

Images formed by a plane mirror

- Virtual –
  - Reflected rays – never intersect – image formed – virtual (imaginary)
  - Cannot be obtained on screen
- Same size –
  - Image formed – same size as object
- Erect –
  - Forms erect (upright) image
- Laterally inverted –
  - Reversed from left to right
- Position –
  - Image distance from mirror is equal to object distance from mirror
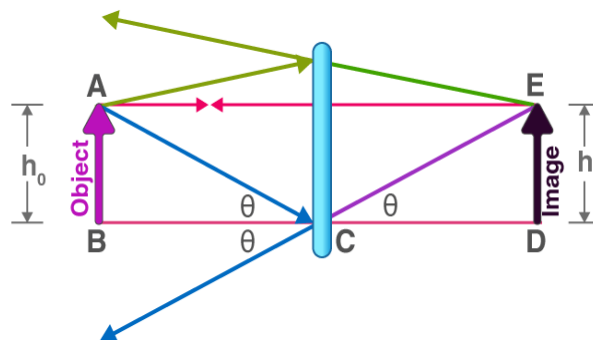
Types of reflection

- Reflection of light – depends on properties of reflective surface
- Classified into –
  - Regular reflection –
    - Takes place at shiny surfaces
    - Mirrors, steel plates, etc
    - Beams of light – remain parallel after reflection
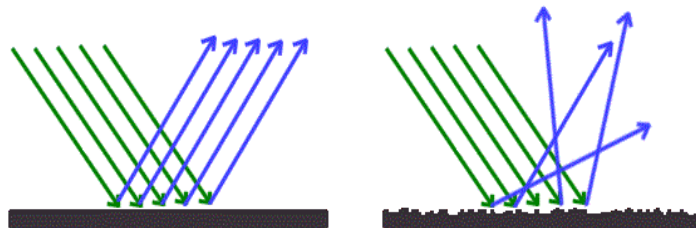
  - Diffused reflection –
    - Takes place at rough surfaces
   - Newspapers, books, tables, etc

- Helps in seeing – rays of light reflect at different angles
- Does not mean – failure of laws of reflection – happen due to irregular surfaces
  o Multiple reflection –
    - Barber shop, garment shop – multiple mirrors – multiple images
    - One plane mirror – one image
    - Multiple mirrors – different angles – different images
    - Decrease angle between mirrors – no of images increase
    - If angle is 0 – parallel mirrors – infinite images

    - **Kaleidoscope** – use this property – make patterns

Dispersion

- White light – seven different colours – rainbow of **spectrum**
- Process – light breaks into seven colours – **dispersion**
- Order of colour – **VIBGYOR** – **V**iolet, **I**ndigo, **B**lue, **G**reen, **Y**ellow, **O**range, **R**ed
- Can be seen on – transparent scales, CDs, water droplets, oil films
- Laboratories – prism – disperse light
- Prism – transparent medium
- 1st observed by Sir Isaac Newton – white ray of sunlight enters one face – dispersed rays of coloured light leaves from another face
- Rainbow – formed with same property
- Ray of sunlight – falls on water droplets – dispersion occurs – rainbow appears
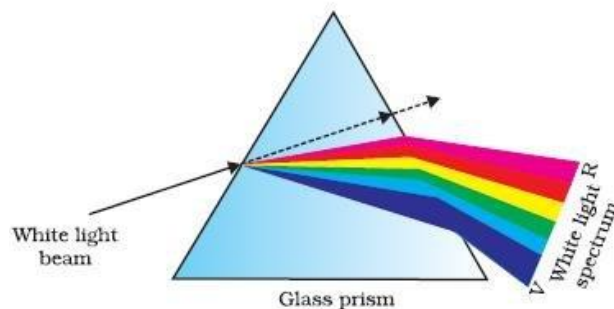
Structure of the human eye

- Eye – organ – enables us to see
- Light enter eye – image is formed – transmitted to brain
- Different parts –
  o Cornea
    - Outermost thin, tough, curved transparent membrane – front of the eye
    - Light enters through cornea – helps focus light to retina

- o Pupil, Iris
  - ▪ Behind cornea – dark, muscular mechanism
  - ▪ Centre of iris – pupil
  - ▪ Iris – control width of pupil – control entry of light
  - ▪ Bright light – pupil – narrow – reduces amount of light entering eye
  - ▪ Dark conditions – opposite happens – pupil – widens – increases amount of light entering eye
  - ▪ Colour of eyes – colour of iris
- o Lens
  - ▪ Behind the pupil – thick in the middle
  - ▪ Convex lens – variable thickness – focuses light to form image on retina
- o Retina
  - ▪ Layer – light-sensitive cells – covers back of eye from inside
  - ▪ Light falls on retinal cell – electrical impulse from cell – transmitted to the brain via **optic nerve**
  - ▪ Brain – interprets impulses – recognizes image
- o Humour
  - ▪ Transparent fluids – fill up eyeball – keeping everything in place
  - ▪ Fluid – between cornea and lens – aqueous humour
  - ▪ Fluid – between lens and retina – vitreous humour
- o Ciliary muscles
  - ▪ Controls thickness of eye lens
  - ▪ Muscles tighten – lens thicker – muscles relax – lens thinner
  - ▪ This process - **accommodation**
- Retina contains cells – help us see colours
- 2 types of cells –
  - o Rod-shaped –
    - ▪ Black, white, grey and night vision
  - o Cone-shaped –
    - ▪ Allow us to see in strong light
      - 3 kinds – One for blue, One for red, One for green
    - ▪ They work together – help us see all colours
- **Macula** or **yellow spot** – centre of retina – maximum number of cells – brightest vision
- **Blind spot** – just below macula – no receptors – no vision
- Addition to these parts – eyelids – keeps our eyes safe from harmful objects – dust, dirt
- Also save us from bright light
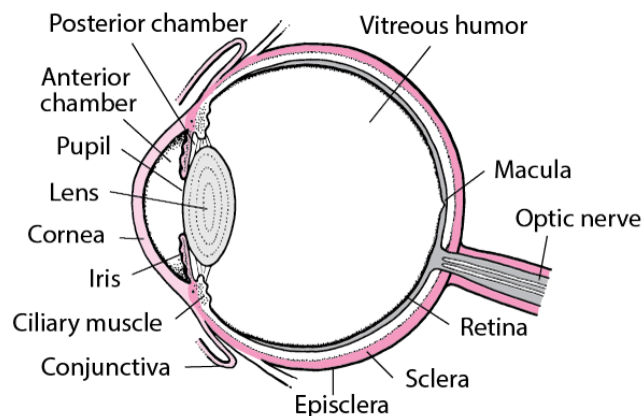
Persistence of vision

- Impression of objects – remain on retina – 1/16th of a second
- This property – **persistence of vision**
- Sequence of images – flashes before our eyes – faster speed (more than 16 images per second) – looks like a video (in motion)

Defects of vision

- Lots of people – wear spectacles or contact lenses
- Most common eye defects –
  - o Myopia –
    - Short sightedness
    - Eye balls too long – OR – eye lenses too thick
    - Blur vision – seeing far away objects
    - Can see nearby objects perfectly
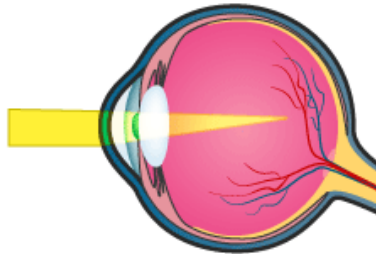
  - o Hypermetropia –
    - Long sightedness
    - Eye balls too short – OR – eye lenses too thin
    - Blur vision – seeing nearby objects
    - Can see far away objects perfectly
    - Comfortable distance at which human eye can read – 25 cm
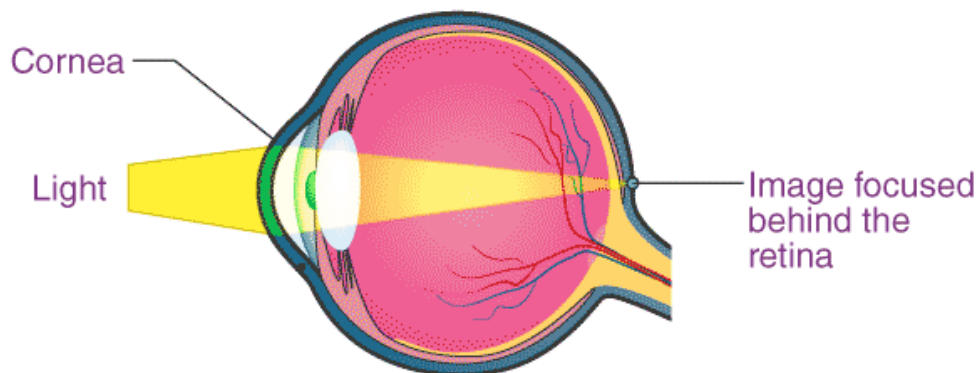
  - o Astigmatism –
    - Cylindrical power
    - Eye – cannot focus on vertical and horizontal line
  - o Cataract –
    - Sometimes – eye lens becomes cloudy
    - Enzymes from ciliary muscles – cloud over lens
    - Severe cases – lens becomes opaque

- - - Opacity of lens – most common with diabetes
    - Can be cured with laser surgery
  - Colour blindness –
    - Usually hereditary
    - Less cone-shaped cells – sense colours
    - Cannot recognize some colours
  - Night blindness –
    - Due to deficiency of vitamin A
    - Difficult to see in dim light
  - Blindness –
    - Severe loss of vision – inability to see
    - May be caused by injury or disease
    - May be blind by birth

Visual aids

- Braille text –
  - Method for reading of blinds
  - Series of dots – read by feeling impressions
  - Developed by **Louis Braille**
  - Consist upto 6 dots – arranged in rectangular blocks
  - 1ˢᵗ book in braille – 1827 – visually impaired (blind) persons – achieve education and employment
- Audio books –
  - Textbooks, storybooks, etc – available in audio forms
  - Softwares – convert text to audio and vice-versa
  - Visually impaired – read and write books
- Computer software –
  - Special computers and softwares – audio sensors – help blinds

- Many other devices – talking calculators, audio dictionaries, etc

Eye care

- Specialized organs – need daily care
  - Nutrition –
    - Deficiency of Vitamin A – cause night blindness and poor vision
    - 600 mg Vitamin A – daily intake
    - Present in yellow fruits, tomato, carrot, milk, cheese
  - Protection –
    - Protect your eyes from bright light – wear sunglasses
  - Daily care –
    - Wash with clean water – twice a day
    - Eyes – gets dry – longer screen time
    - Blink eyes regularly – keep them wet
  - Do not rub your eyes – ensure sufficient light during reading or writing