Chapter 4: Refraction of Light at Plane Surfaces

Reflection of Light

- **Definition:** The return of light into the same medium after striking a polished surface.
- **Laws of Reflection:**
    1. Angle of incidence = Angle of reflection.
    2. Incident ray, normal, and reflected ray lie in the same plane.

Refraction of Light

- **Definition:** The change in the direction of light when it passes from one transparent medium to another.
- **Cause:** Change in speed of light between two media.
- **Observations:**
    1. Rarer → Denser: Light bends **towards** the normal.
    2. Denser → Rarer: Light bends **away** from the normal.
    3. Normal incidence: No deviation.

Laws of Refraction (Snell's Law)

1. Incident ray, refracted ray, and normal lie in the same plane.
2. $\frac{\sin i}{\sin r}$=constant

Refractive Index (μ)

- $\mu = \frac{Speed\ of\ light\ in\ vacuum\ (c)}{\text{Speed of light in medium (V)}}$
- **No unit** (it's a ratio).
- **μ > 1** implies light slows down in the medium.

Effect of Refraction on Light Properties

- **Speed (V):** Changes.
- **Frequency (f):** Constant.

- **Wavelength (λ):** Changes.
- Relation: $V = f\lambda$

Factors Affecting Refractive Index

1. **Nature of medium**
2. **Temperature** ↑ → Refractive index ↓
3. **Wavelength/Colour:** $\mu_{violet} > \mu_{red}$

Principle of Reversibility of Light

- Light path is reversible in refraction.

Lateral Displacement

- Perpendicular shift of the emergent ray.
- Increases with:
    1. Thickness
    2. Angle of incidence
    3. Refractive index

Glass Slab & Multiple Images

- Thick slabs can show multiple, fading images.
- Images are due to multiple reflections and refractions.

Prism and Refraction

- **Deviation of light** depends on:
    1. Angle of incidence
    2. Material (μ)
    3. Angle of prism
    4. Colour: Violet deviates most.

Real vs Apparent Depth

- Objects in water/denser medium appear **shallower**.
- Depends on:
    1. Refractive index
    2. Medium's thickness
    3. Light colour

Refraction Phenomena in Daily Life

- Twinkling stars
- Early sunrise/late sunset
- Coin reappears in water
- Raised appearance of text under glass
- Shallow appearance of water tanks

Critical Angle & Total Internal Reflection (TIR)

- **Critical Angle (C):** Angle of incidence for 90° refraction.
- $\mu = \frac{1}{\sin C}$
- **Conditions for TIR:**
    1. Light must travel from **denser to rarer** medium.
    2. Angle of incidence > critical angle.

TIR in Prisms

1. **45°-90°-45° Prism:** Deviates light 90° or 180°.
2. **Equilateral Prism (60°):** Normal refraction + dispersion.
3. **30°-60°-90° Prism:** TIR not always possible.

Applications of TIR

- **Mirage:** Illusion of water on roads.
- **Diamond sparkle**
- **Cracked glass reflection**

TIR vs Reflection from Plane Mirror

Total Internal Reflection	Plane Mirror Reflection
Only from denser to rarer	From any medium
100% light reflected	Partial reflection
No energy loss	Some energy lost