5 Optics

5.1 Refraction of Light

When considering the effect of lenses or mirrors on the path of light, we draw diagrams using **light rays** and **normals**.

- **Light rays** represent the direction of travel of wavefronts.
- The **normals** is an imaginary line perpendicular to a boundary between two materials or a surface.

Refraction is the change of direction that occur when light **passes at an angle** across a boundary between two **transparent substances**. When entering a glass block from air, the light ray bends

- **Towards the normal** when it passes from air into glass.
- **Away from the normal** when it passes from glass into air.

No refraction takes place if the incident light ray is along the normal.

At a boundary between two transparent substances, the ray bends towards the normal if it passes into a **more dense substance**.

Investigating Refraction by Glass

1. Use a **ray box** to direct a light ray into a **rectangular glass block** at different angles of incident at point P on one of the sides.
2. For each angle of incidence, mark point Q where the light leaves the block.

The **angle of incidence** is the angle between the incident light ray and the **normal** at the point of incident. The **angle of reflection** is the angle between the refracted light ray and the normal at the point of incident.

- The angle of diffraction r is always less than the angle of incident i.
- **Snell's law**: the ratio $\sin i / \sin r$ is the same for each light ray.
  - The ratio is referred to as the **refractive index** n of glass.

$$\text{refractive index of the substance } n = \frac{\sin i}{\sin r}$$

Partial reflection also occur when a light ray in air enters any refractive substance.

The angle of refraction of the light ray emerging from a rectangular glass block is the same as the **angle of incidence** of the ray entering the block.

- The two side of the block are **parallel to each other**.
- Refractive index when entering the glass is n, when leaving the glass is $1/n$, so the combined effect is $n = 1$.