Refraction

Transmission can lead to **refraction**. As a wave is transmitted from one material to the other, it can be refracted. Refraction is when a wave **changes direction** as it crosses a boundary. This means that the wave will enter the material in one direction and leave the material in another direction.

Refraction of light

- **Refraction** occurs when light passes a **boundary** between two different transparent materials
- At the boundary, the rays of light change **direction.**
- This change in direction depends on the difference in **density** between the two media:

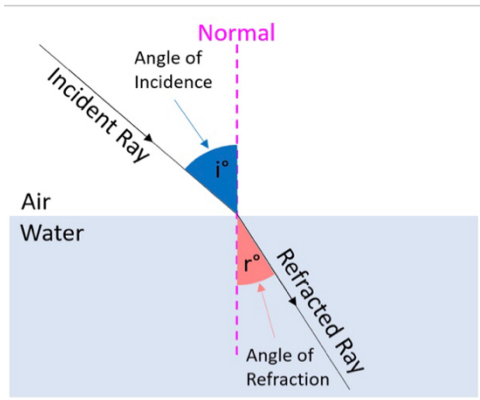
  a. From **less dense to more dense** (e.g air to glass), light bends **towards** the normal

  b. From **more dense to less dense** (e.g. glass to air), light bends **away** from the normal

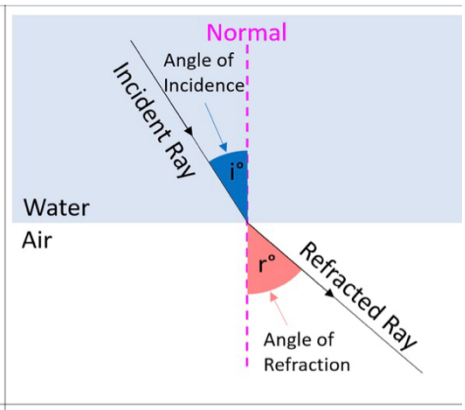
  c. When passing along the **normal** (perpendicular) the light **does not bend** at all

- When a light wave enters and leaves the glass block there are **two** boundaries. The **refracted** ray at the **first** boundary becomes the **incident** ray at the **second** boundary
- The **change in direction** occurs due to the **change in speed** when traveling in different substances
- When light passes into a denser substance, the waves will **slow down**; hence, they bend **towards the normal.**
- The only properties that **change** during refraction are **speed and wavelength** – the frequency of waves **does not change**
- Different frequencies account for different **colors** of light (red has a low frequency, whilst blue has a high frequency).
- When light refracts, **it does not change color** (think of a pencil in a glass of water), therefore, the frequency does not change.

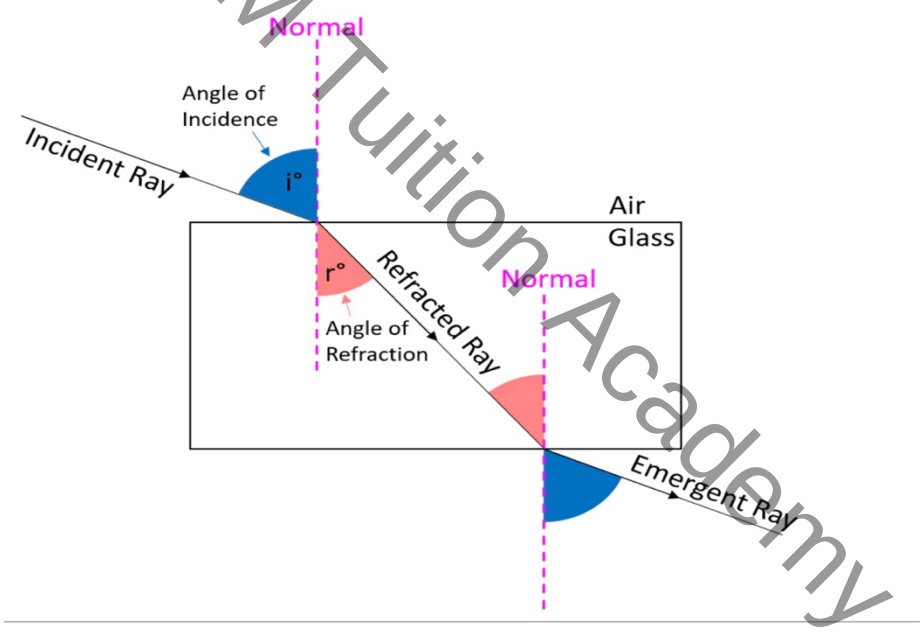
ASM Tuition Academy



When a ray of light moves from air into water the ray is **refracted** towards the normal.



When a ray of light moves from water into air the ray is **refracted** away from the normal.



When a ray of light moves from air into glass the ray is **refracted** towards the normal and when it moves from glass into air the ray is **refracted** away from the normal

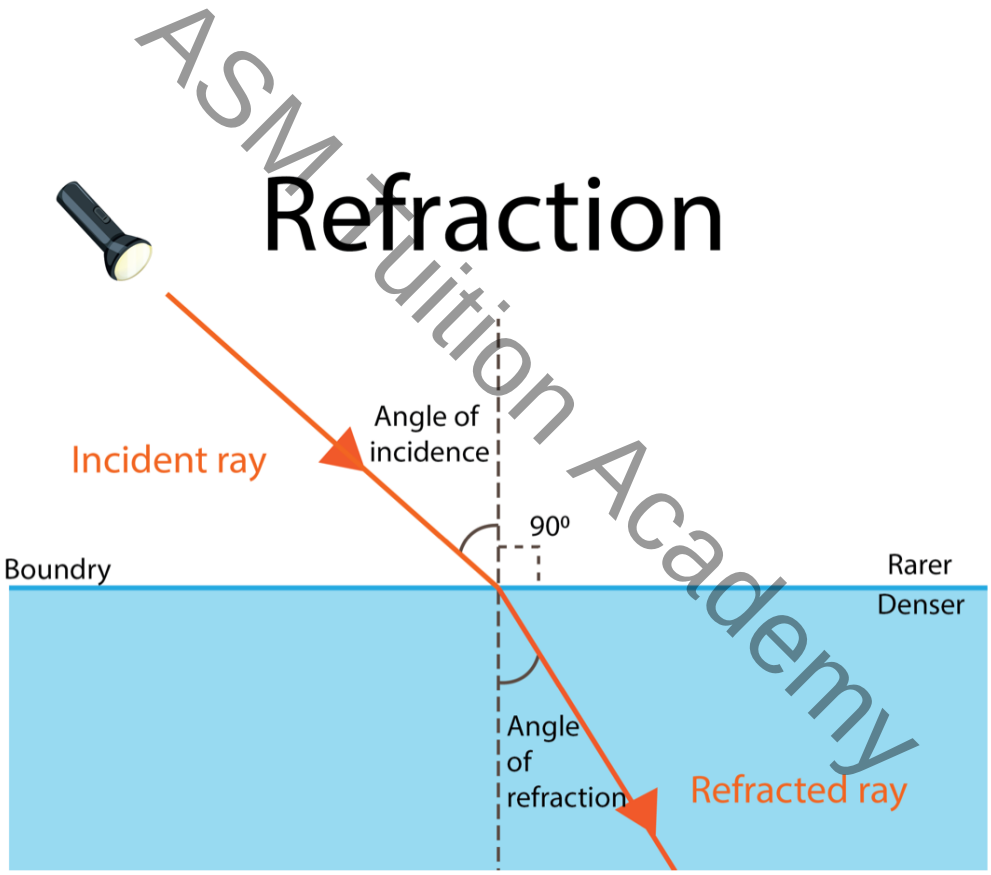
ASM Tuition Academy

Ray diagrams for refraction

- In refraction, angles are measured between the ray (showing the direction of the wave) and the normal line
- The angle of the wave approaching the boundary is called the **angle of incidence** ***(i)***
- The angle of the wave leaving the boundary is called the **angle of refraction** ***(r)***
- When drawing a ray diagram an arrow is used to show the direction the wave is travelling

1. An **incident** ray has an arrow pointing **towards** the boundary
2. A **refracted** ray has an arrow pointing **away** from the boundary

- The **angles** of **incidence** and **refraction** are usually labelled ***i*** and ***r*** respectively



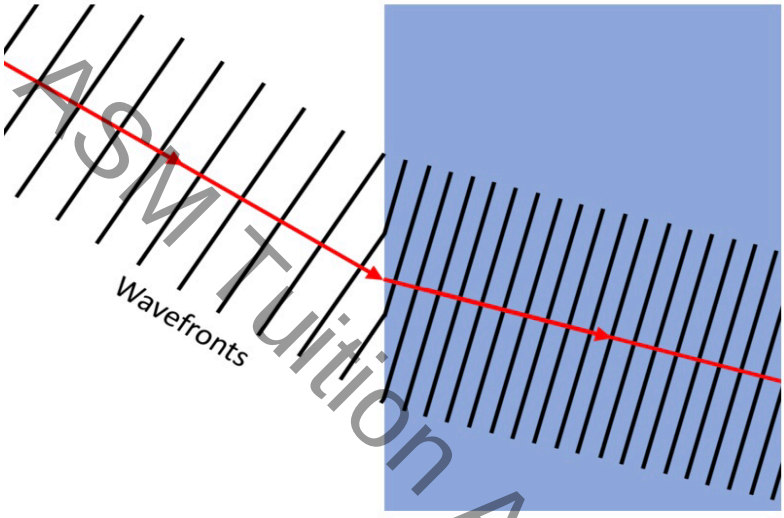
ASM Tuition Academy

Explain refraction using Wave front diagrams

Wavefront: A wavefront is an imaginary surface representing corresponding points of a wave that vibrate in same direction.

OR

A wavefront is the set of all locations in a medium where the wave is at the same phase. This could be where all the crests are, where all the troughs are, or any phase in between.



This diagram shows the wavefronts of a wave arrive at an interface where they slow down. The wave changes direction because one side of the wavefront slows before the other side.

ASM Tuition Academy