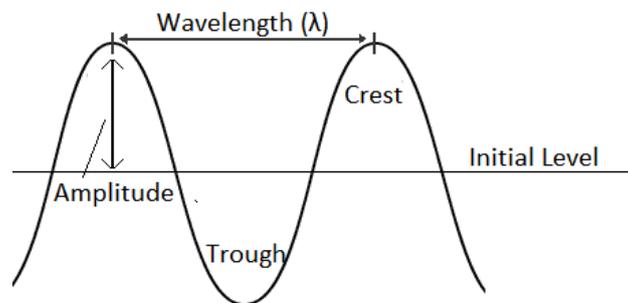


Light and Waves Notes

Waves

- A wave is a **motion used to carry energy**. If there is more energy, there will be less wavelength.



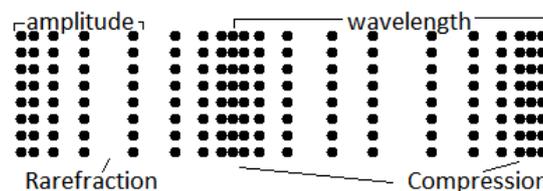
- A wave crest forms when the particles **move up from the initial level**, and a wave trough is formed when the particles **move down**.
- Waves carry **energy away from the source**, not matter.

Two Types of Waves

- There are two types of waves – **mechanical** waves and **electromagnetic** waves.
- Mechanical waves **require mediums in which to move**. For example, ocean waves are mechanical, as the water surface is the medium it travels on.
- Electromagnetic waves **do not require a medium**. For example, light can travel through a vacuum.

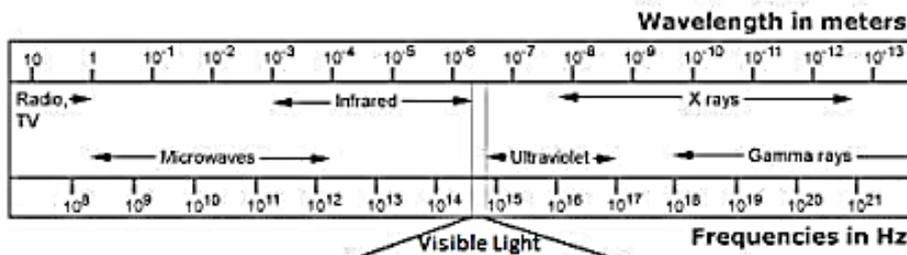
Types of Mechanical Waves

- When a mechanical wave passes through a medium, it can move **two ways**.
- It can move in the form of a **transverse wave**, where the particles move **up and down, perpendicular** to the direction it is travelling.
 - o Examples include water waves and radio waves, like the one shown above.
- It can also move as a **longitudinal wave**, where the particles move **to and fro**, along the axis where it is travelling.
 - o An example is a sound wave, like the one below.



Electromagnetic Waves

- The electromagnetic spectrum is made of a **family of waves** from **high frequency** (small wavelength) to **low frequency** (long wavelength).
- All waves travel at the **speed of light**, $3 \times 10^8 \text{ m/s}$
- **No medium** is needed, and they can travel in a vacuum.
- Electromagnetic waves move in **oscillating electric and magnetic waves**, shown on the right diagram.



Terminology and Formulas

- **Wavelength (λ)** – the distance between two crests or two troughs – metres
- **Amplitude (A)** – the height of a crest measured from the midway point/initial level – metres
- **Frequency (f)** – the number of waves passing a fixed point in 1 second – hertz, Hz
- **Velocity (v)** – the distance moved by a crest in 1 second – metres per second, m/s

Mathematical formulas include:

- The **period (T)** of a wave is the reciprocal of the **frequency (f)**: $T = \frac{1}{f}$
- The **velocity** of a wave is related to the **wavelength** and **frequency**: $v = f\lambda$

Light

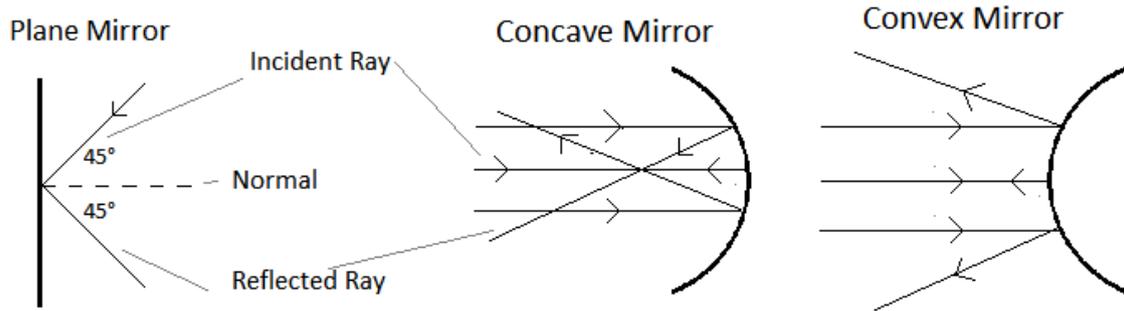
- Light energy is the general name for **all forms of electromagnetic waves**.

Terminology

- The incident ray is the ray **moving toward** the surface.
- The reflected ray is the ray **moving from** the surface.
- The normal is an imaginary line **perpendicular** to the surface.
- Angle of incidence is the angle between **the incident ray and the normal**.
- Angle of refraction is the angle between **the reflected ray and the normal**.
- **The law of reflection** states that the angle of incidence is **equal** to the angle of reflection.

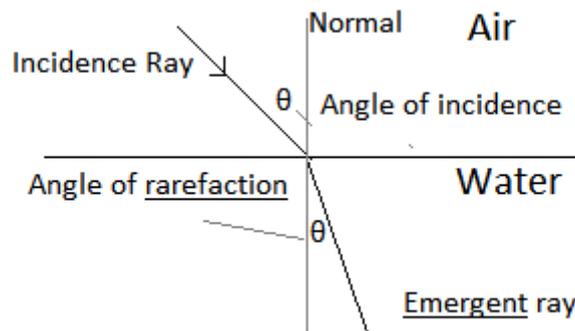
Reflection

- Light reflects off mirrors, and can reflect differently off plane and curved mirrors.
- In a regular, **plane** mirror, parallel rays strike a smooth surface. The reflected rays bounce off the surface **parallel** to each other.
- In a curved, **concave** mirror, parallel rays strike the surface and the reflected rays bounce off **away** from each other.
- In a curved, **convex** mirror, parallel rays strike the surface and the reflected rays bounce off **towards** each other, and may **join at a point**.

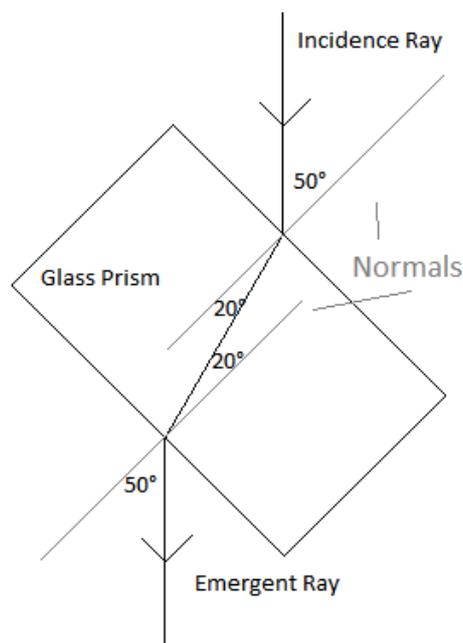


Rarefaction

- Rarefaction is the **bending of light** as it moves from **one medium to another**.

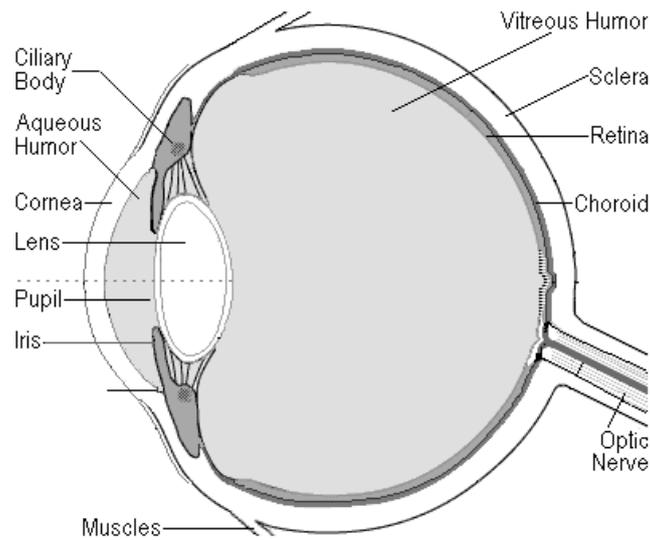


- The **more dense** the material is, the **closer** the emergent ray is **to the normal**. Therefore, water is more dense than air.



- Glass is more dense than air. When a ray **enters glass**, the emergent ray **goes closer** to the normal. When a ray, from the glass, **exits into air**, the emergent ray is **further away** from the normal.

The Eye



- There are three layers protecting the eye – **sclerotic coat, choroid coat and retina**.
 - o The **sclerotic coat** is the white, tough wall of the eye.
 - o The **choroid coat** supplies blood to the retina.
 - o The **retina** is the film of the eye, converting light to signals and sends to the brain through **optic nerves**.
- **Vitreous humor** is a jelly-like liquid that fills most of the eye. It helps protect the eye.
- The **pupil** is the hole in the centre of the **iris** that light passes through. The iris muscles control its size.
- The **lens** focuses light rays into the retina. It is held up by the **ciliary body**, which also produces humor.
- The **cornea** is the clear part, which lets light into the eye. **Aqueous humor** is held in between the cornea and iris, and provides nutrients to the cornea and lens.

Comparisons to a (Manual) Camera

Part of the Eye	Part of the Camera	Camera Part's Function
Sclera	Case	Protects the camera
Choroid	Black paint	Protects the camera
Retina	Film	Records and processes picture
Iris	Iris diaphragm	Adjustable circle used to stop light
Lens	Lens	Makes light changeable to store digitally
Eyelid	Shutter	Protects the front of the lens