Waves

Physics – Leaving Cert

Quick Notes

Waves

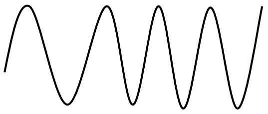
A wave is a means of transferring energy from one point to another

Waves can be classified as mechanical – where the wave must have a medium to travel through, or electromagnetic, which can travel through a vacuum.

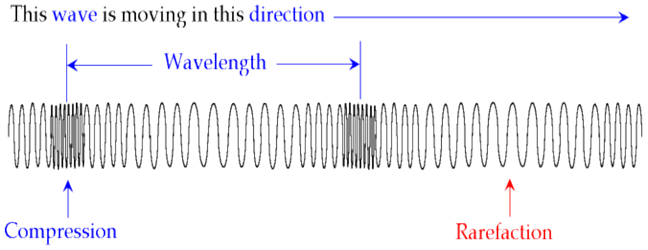
A travelling wave is a wave travelling out from a source, transferring the energy from the source to other places through which it passes.

A travelling wave can be one of two types

Transverse wave = where the direction of vibration is perpendicular to the direction of motion of the wave. Light travels as a transverse wave



Longitudinal wave = where the direction of vibration is parallel to the direction of motion of the wave. Sound travels as a longitudinal wave.



If the same motion is repeated periodically the wave is called a periodic travelling wave

Terminology

Amplitude (A)= maximum displacement from equilibrium (m)

Wavelength (λ)= Distance from one point on a wavefront to the same point on the next wavefront (m)

Frequency (f)= number of complete wavefronts passing a point per second. (Hz)

The wave equation

For any periodic wave, of frequency f, wavelength λ and travelling at speed c the following equation holds

$$C = f\lambda.$$

Properties of a Wave

All waves have the following properties

Reflection, refraction, Diffraction and interference.

Reflection of waves- bouncing of a wave off a barrier

Refraction- The change in direction of a wave as it travels from a medium of one density to another density.

Diffraction- the spreading out of a wave into a region beyond a barrier

Interference – when two waves meet a new wave is formed. The new amplitude is the algebraic sum of the two original amplitudes

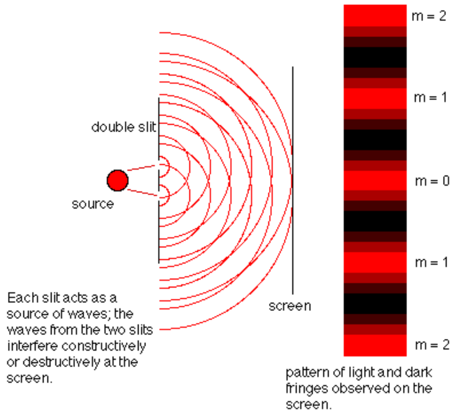
If the resulting amplitude is bigger than the original amplitudes the waves are said to undergo **constructive interference**, if the resulting amplitude is smaller than the original amplitude the waves are said to undergo **destructive interference**.

Coherent sources

Two sources of periodic waves are said to be coherent if they are in phase(crests of both waves meeting, troughs meeting) or have a constant phase difference between them(one lags the other by a full wavelength or two full wavelengths etc.)

Interference pattern

When waves from coherent sources meet the resulting wave pattern is called an interference pattern.



Looking along line C_0 crest is meeting crest and trough is meeting trough – constructive interference- antinodal line

Looking along line D_1 crest is meeting trough and trough is meeting crest – destructive interference – nodal line.

Polarisation:

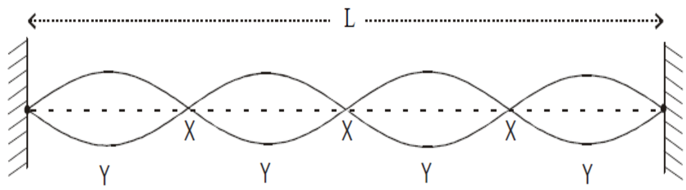
A Polaroid is a piece of transparent material which consists of long strings of molecules lined up next to each other. |As such, between the molecules there exist slits, parallel to each other.

Normal light is unpolarised – vibrates in all planes. When this light reaches the Polaroid only the light vibrating in the same plane as the slits in the Polaroid will get through – all other light is stopped.The light is now said to be plane polarized. If a second Polaroid is lined up with its slits parallel it will have no effect, if its slits are perpendicular no light gets through.

NOTE: only transverse waves can be polarized.

Stationary waves:

If a rope is held fixed at one end and the other end vibrated a stationary wave pattern can be set up.



Some points will be at rest (nodes=x) while other points will vibrate with a maximum amplitude(antinodes=y). The wave remains stationary.

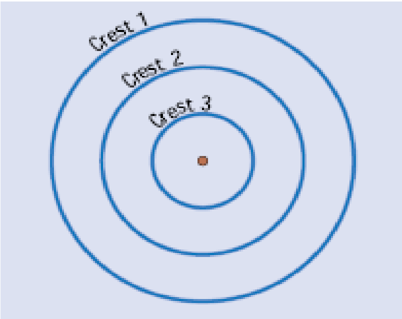
Distance between two consecutive nodes (or antinodes) = $\frac{\lambda}{2}$

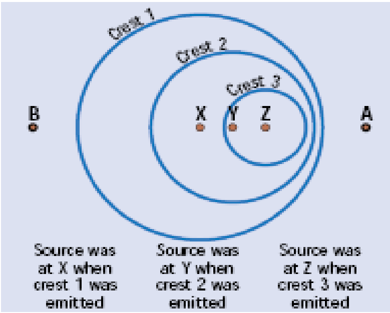
Distance between node and next antinode = $\frac{\lambda}{4}$

Stationary waves can be set up in both transverse and longitudinal waves.

***Doppler effect:

The apparent change in frequency of a wave due to the motion of the source of the wave.

(i) 

(ii) 

In diagram (i) the source is stationary so all observer will observe the same distance between crests (i.e. the same wavelength)

In diagram (ii) the source is moving between emitting wavefronts so the observer at A observes wavefronts closer together than the stationary case while observer at B observes wavefronts further apart than the stationary case. Hence A observes a shorter wavelength (greater frequency) wave while the observer at B observes a longer wavelength (smaller frequency) wave.

Source approaching observer

$$f' = \frac{fc}{c-u}$$

Source moving away from observer

$$f' = \frac{fc}{c+u}$$

f' = observed frequency, f = frequency emitted, c = speed of wave, u = speed of source.