# Interference

Interference is a special case of superposition where the waves that combine are coherent. The waves overlap and form a repeating interference pattern of maxima and minima areas. If the waves weren't coherent the interference pattern would change rapidly and continuously.

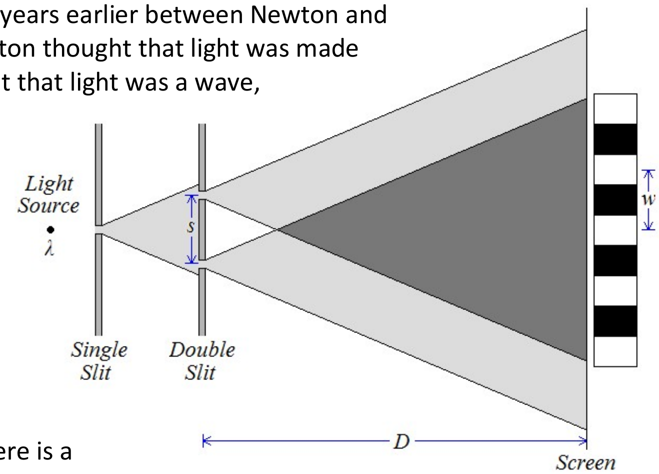
***Coherence:*** Waves which are of the same frequency, wavelength, polarisation and amplitude and in a constant phase relationship. A laser is a coherent source but a light bulb is not.

***Constructive Interference:*** The path difference between the waves is a whole number of wavelengths so the waves arrive in phase adding together to give a large wave. *2 peaks overlap*

***Destructive Interference:*** The path difference between the waves is a half number of wavelengths so the waves arrive out of phase cancelling out to give no wave at all. *A peak and trough overlap*

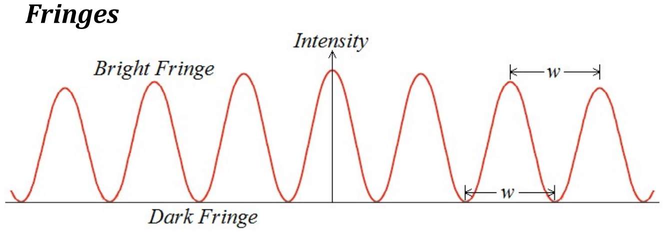
## *Young's Double Slit Experiment*

In 1803 Thomas Young settled a debate started over 100 years earlier between Newton and Huygens by demonstrating the interference of light. Newton thought that light was made up of tiny particles called corpuscles and Huygens thought that light was a wave, Young's interference of light proves light is a wave. Here is Young's double slit set up, the two slits act as coherent sources of waves




Interference occurs where the light from the two slits overlaps. Constructive interference produces bright areas, while deconstructive interference produces dark areas. These areas are called interference fringes.

### *Fringes*



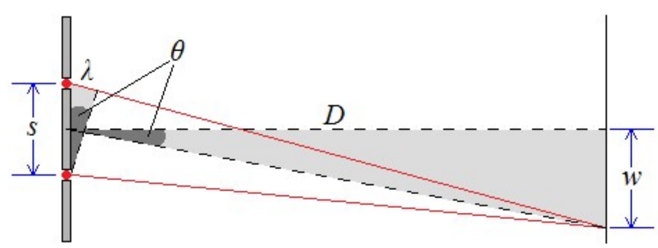

There is a central bright fringe directly behind the midpoint between the slits with more fringes evenly spaced and parallel to the slits.
As we move away from the centre of the screen we see the intensity of the bright fringes decreases.

## *Double Source Experiment*

The interference of sound is easy to demonstrate with two speakers connected to the same signal generator. Waves of the same frequency (coherent) interfere with each other. Constructive interference produces loud fringes, while deconstructive interference produces quiet fringes.

## *Derivation*

We can calculate the separation of the fringes ($w$) if we consider the diagram to the right which shows the first bright fringe below the central fringe. The path difference between the two waves is equal to one whole wavelength ($\lambda$) for constructive interference. If the distance to the screen ($D$) is massive compared to the separation of the sources ($s$) the angle ($\theta$) in the large triangle can be assumed the same as the angle in the smaller triangle.




$\sin\theta = \frac{Opposite}{Hypotenuse}$ For the small triangle: $\sin\theta = \frac{\lambda}{s}$ For the large triangle: $\sin\theta = \frac{w}{D}$

Since the angles are the same we can write $\frac{w}{D} = \sin\theta = \frac{\lambda}{s}$ or $\frac{w}{D} = \frac{\lambda}{s}$ which rearranges to: $\boxed{w = \frac{\lambda D}{s}}$

**Fringe Separation, Source Separation, Distance to Screen and Wavelength are measured in metres, m**