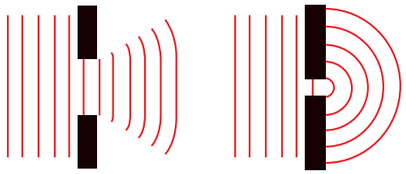
GCE Physics Unit 2.5 Wave Properties

Diffraction:

Diffraction it is the spreading of a wave which occurs when it passes through a slit or obstacles.



If the slit is much larger than the wavelength, little diffraction occurs, but if the wavelength is greater than or equal to the slit width the wave is spread through 180°.

Superposition:

Superposition occurs when two waves meet. If this happens then the total displacement is the vector sum of their individual displacements at that point.

Constructive interference (wave A and B in phase)

If wave A and B occupy the same space, superposition will cause constructive interference and will create a wave with the amplitude of A+B.

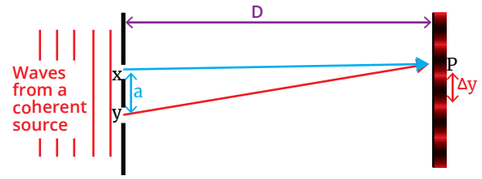
Destructive interference (wave A and B in antiphase)

If wave A and B occupy the same space, superposition will cause destructive interference and will cause the amplitude to be 0.

Double slit:

When interference from two coherent sources occurs a pattern of bright and dark fringes appears.

This occurs with all waves, including water waves and sound waves. As this was observed happening with light, it was the **first experiment to prove that light was a wave**.



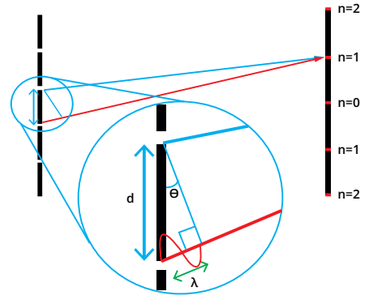
The equation used to calculate the wavelength from this experiment is:

$$\lambda = \frac{a\Delta y}{D}$$

As the wave from y to P has to **travel further** than from x to P, the waves will have a phase difference of 2π. The **extra distance travelled is equal to 1 wavelength**, therefore the waves constructively interfere. At a dark fringe, destructive interference has occurred so there is a **difference of ½ λ**.

Diffraction grating:

A diffraction grating is an opaque material with many **narrow, parallel equally spaced slits**. Similar to the double slits, when a light from a coherent source travels through a diffraction grating a pattern of bright fringes appears.



The bright fringes are again caused by **constructive interference**. Therefore, at a bright point the phase difference from the different slits is equivalent to **an integer number of wavelengths**.

The wavelength can be calculated using this equation:

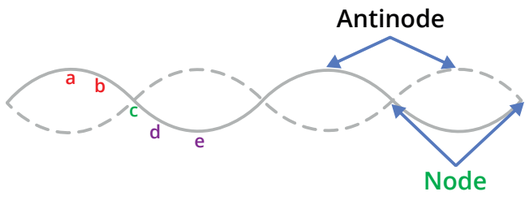
$$n\lambda = dsin\theta$$

Remember that d = separation of slits, the diffraction grating will often be described as having a number of lines per mm. You can calculate d from this by **dividing the unit length by the number of lines**.

Stationary waves:

Stationary waves are created when two waves of equal frequency and amplitude, travelling in opposite directions interfere with each other. This is often created by waves from one source reflecting back towards it.

This is the 4th harmonic.



Key points

- At the **nodes amplitude = 0**
- Amplitude is **maximum at the antinodes**.
- **Phase between the nodes is constant**, e.g. points **a and b are in phase**. Although their amplitude is different.
- **Phase changes by π at the nodes**, e.g. points **a and b** are in antiphase to **d and e**.
- The distance between the nodes is $\frac{\lambda}{2}$
- Stationary waves do not transfer energy.

λ = wavelength in m

a = separation of slits in m (double slits)

Δy = fringe separation

D = distance from the slits to the screen in m

d = separation of slits in m (diffraction grating)