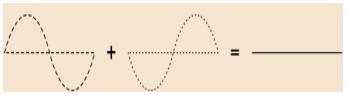
Waves Interference

Definitions

Wave interference occurs when two waves meet while traveling along the same medium. The **principle of superposition** states that when two waves interfere, the resulting displacement of the medium at any location is the algebraic sum of the displacements of the individual waves at that same location.

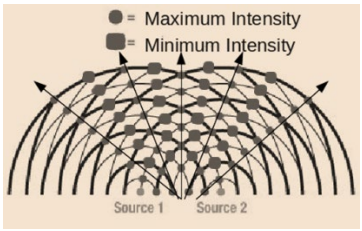
When the waves add up to form a larger resultant this is called constructive interference (if the waves have the same amplitude, the resultant is double the amplitude).

When the waves add up to form a smaller resultant this is called destructive interference (if the waves have the same amplitude, the resultant is zero amplitude).



Wave interference also occurs for 2-point interference.

The interference of two diffracted waves with the same frequency produces antinodal lines (maximum intensity) and nodal lines (no displacement).



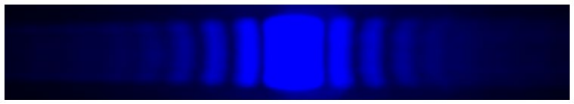
(Only the antinodal lines are shown above)

Antinodal lines occur where there are a series of points of constructive interference (the waves add up to form a larger resultant) in a line. Nodal lines occur where there are a series of points of destructive interference (the waves add up to form a smaller resultant) in a line.

Questions

LIGHT WAVES AND BARRIERS (2022;2)

Helen decides to investigate wave movement and barriers. She starts by shining a purple light, with a frequency of 7.5×10^{14} Hz, on the wall. She then shines the same light through a double slit and observes the following pattern formed on a screen.



(a) Complete a labelled wave diagram to show how this phenomenon occurs.

(b) Use physics principles to describe and explain how the pattern is formed. Start by naming the phenomenon that is taking place, and then discussing the conditions required for the pattern to form.

Terms

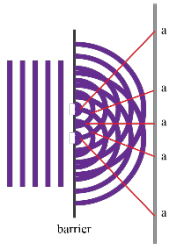
Amplitude (of waves): The maximum displacement of particles of the medium from their mean positions during the propagation of a wave
Antinodal lines: Lines of constructive interference
Antinode: A point of maximum amplitude because of constructive interference of waves
Constructive interference: Two waves arriving at the same place, at the same time and in phase, add amplitudes to create a wave with a larger amplitude.
Destructive interference: Two waves arriving at the same point at the same time out of phase add their amplitudes to create zero total disturbance.
Node: A point in a stationary wave without any disturbances. Destructive interference occurs at nodes.
Nodal lines: Lines of destructive interference
Superposition: When two or more waves occupy the same position at the same time, they 'overlap' and show a combined pattern

Tips

- There are no equations in this part of the topic – just diagrams and descriptions.

Answers

(a) Antinodes labelled or clearly shown.



(b) Process is interference, waves from each gap need to travel a different distance to the screen. When the path difference is a multiple of a whole wavelength, the waves arrive in phase, and constructive interference occurs forming antinodes / bright spots. When waves arrive out of phase, destructive interference occurs and dark spots / nodes occur.