WJEC England Physics AS-level

2.5 Wave Properties

Flashcards

Why is a laser useful in showing interference and diffraction?

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It produces monochromatic (same wavelength/colour) light meaning diffraction and interference patterns are more defined.

What was Young's double-slit experiment?

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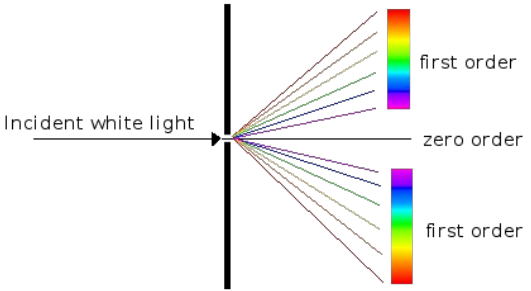
A single light source is directed towards two slits, which each act as a coherent light source. The light interferes constructively and destructively to create an interference pattern.

Describe the interference pattern created using white light.

Describe the interference pattern created using white light.

A bright white central maximum flanked by alternating spectral fringes of decreasing intensity with violet closest to the zero order and red furthest.



http://gemologyproject.com/wiki/index.php?title=Diffraction

Why does an interference pattern form when light is passed through a single slit?

Why does an interference pattern form when light is passed through a single slit?

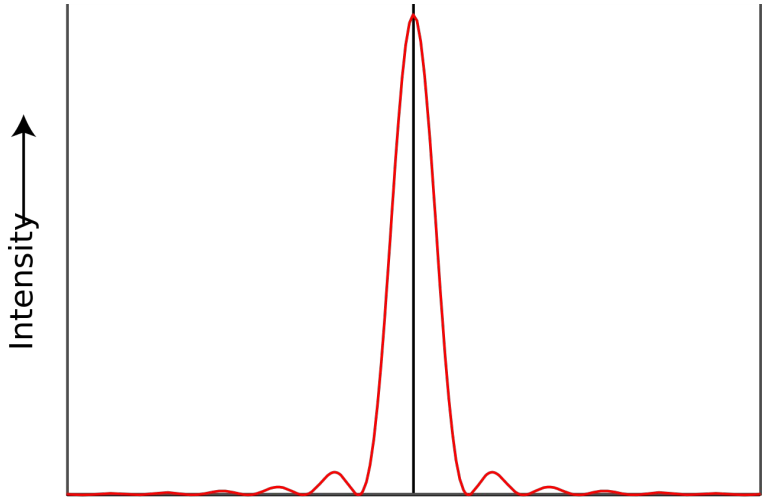
The light diffracts as it passes through the slit. Where the waves are in phase, constructive interference occurs making bright fringes. Where the waves are completely out of phase, destructive interference occurs making a dark fringe.

Increasing the slit width increases the width of the central diffraction maximum. True or False?

Increasing the slit width increases the width of the central diffraction maximum. True or False?

False, the slit is not so close to the wavelength in size so less diffraction occurs- the central maximum becomes narrower and more intense.

Is the following a double slit pattern, single slit pattern or a diffraction grating pattern?



Is the following a double slit pattern, single slit pattern or a diffraction grating pattern?

Single Slit

What is a stationary wave?

What is a stationary wave?

A wave which transfers no energy and whose positions of maximum and minimum amplitude are constant.

What is a node?

What is a node?

A point on a stationary wave where the displacement is 0.

What is an antinode?

What is an antinode?

A point on a stationary wave with maximum displacement.

What are the conditions for a stationary wave to be produced?

What are the conditions for a stationary wave to be produced?

- The waves must be of the same frequency, wavelength and amplitude.
- They must be travelling in opposite directions.

These conditions are often met when a wave is reflected back onto itself.

How are stationary waves produced?

How are stationary waves produced?

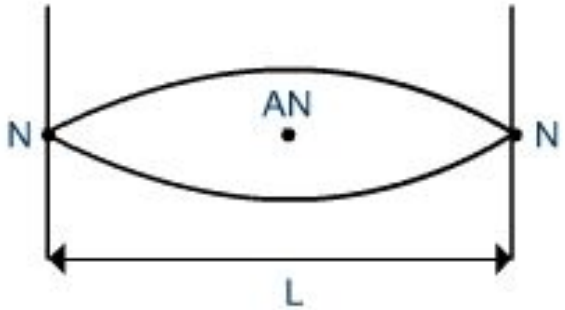
A stationary wave is formed from the superposition of 2 progressive waves, travelling in opposite directions in the same plane, with the same frequency, wavelength and amplitude:

- Where the waves meet in phase, constructive interference occurs so antinodes (regions of maximum amplitude) form.
- Where the waves meet completely out of phase, destructive interference occurs and nodes (regions of no displacement) form.

Describe the first harmonic for a stationary wave with two closed ends.

Describe the first harmonic for a stationary wave with two closed ends.

It consists of 2 nodes at either end and an antinode in the middle.



https://www.s-cool.co.uk/assets/learn_its/alevel/physics/progressive-waves/standing-waves/image3.jpg

Describe the second harmonic for a stationary wave with one open end and one closed end.

Describe the second harmonic for a stationary wave with one open end and one closed end.

It consists of two nodes and two antinodes, with one of the nodes at the closed end and one of the antinodes at the open end.

What is phase difference and what is it measured in?

What is phase difference and what is it measured in?

How much a particle/wave lags behind another particle/wave. It is measured in radians, degrees or fractions of a cycle.

Define coherence.

Define coherence.

Coherent waves have a fixed phase difference and the same frequency and wavelength.

State 2 applications of diffraction gratings.

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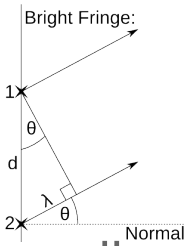
1. Splitting up light from stars to make line absorption spectra - used to identify elements present in stars.
2. X-ray crystallography: a crystal sheet acts as the diffraction grating and the X-rays pass through - used to find the spacing between atoms.

Derive the formula $d\sin\theta = n\lambda$

Derive the formula dsinθ=nλ



https://commons.wikimedia.org/wiki/File:Youngs_slits.png

1. For the first order maximum, the path difference between two adjacent rays of light is 1λ (as shown). The angle between the normal to the grating and the light ray is θ.
2. A right angled triangle is formed, with side lengths d and λ. The upper angle is θ (the lower angle is 90-θ°).
3. For the first maximum sinθ =λ/d, (sin θ = Opp/Hyp) rearrange to dsin =λ,
4. Other maxima occur when the path difference between the two rays of light is nλ, where n is an integer, replace λ with nλ to get: d sin =nλ

When light passing through a diffraction grating is changed from blue to red, do the orders get closer together?

When light passing through a diffraction grating is changed from blue to red, do the orders get closer together?

The wavelength of light has increased so it will diffract more meaning the orders will become further apart.

What is diffraction?

What is diffraction?

The spreading out of waves when they pass through or around a gap.

How did Young's double slit experiment provide evidence for the wave nature of light?

How did Young's double slit experiment provide evidence for the wave nature of light?

Diffraction and interference are wave properties hence the interference pattern of light shows that light has wave properties.

What is path difference?

What is path difference?

The difference in distance travelled by two waves.

How could you investigate stationary sound waves?

How could you investigate stationary sound waves?

Place a speaker at one end of a closed glass tube, lay powder across the bottom of the tube, it will be shaken from the antinodes and settle at the nodes. The distance between each node is half a wavelength.

What is the frequency of the first harmonic of a string length 2m, mass 0.03kg with a mass of 2kg hanging off it?

What is the frequency of the first harmonic of a string length 2m, mass 0.03kg with a mass of 2kg hanging off it?

$$f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

T = tension = 2 x 9.81 = 19.62N

μ = mass / unit length = 0.03/2 = 0.015 kg/m

f = (¼) x (sq.rt: 19.62/0.015)

F = 9.0 Hz

True or False? Only light can produce interference patterns.

True or False? Only light can produce interference patterns.

False, interference patterns can be formed by sound waves and all EM waves too.

What formula is associated with Young's double slit experiment?

What formula is associated with Young's double slit experiment?

$$W = \lambda D/s$$

w - fringe spacing

λ - wavelength of light used

D - distance from screen to slits

s- slit separation