CIE A-Level Physics

15 - Superposition

Flashcards

Define refraction.

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Refraction is when a wave bends at a boundary between two materials due to the difference in density causing it to change speed.

True or false? A wave can either be refracted or reflected at a boundary, but never both.

True or false? A wave can either be refracted or reflected at a boundary, but never both.

False.

At low angles of incidence most will be refracted, but some will reflect.

True or false? Diffraction is most noticeable when the wavelength is much larger than the gap the wave is travelling through.

True or false? Diffraction is most noticeable when the wavelength is much larger than the gap the wave is travelling through.

- False.
- The most diffraction is seen when the gap and the wavelength are the same size.
- If the wavelength is much bigger the waves will be mostly reflected.

Can all waves be polarised?

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No. Only transverse waves can be polarised.

What is the difference between a polarised and unpolarised wave?

What is the difference between a polarised and unpolarised wave?

Polarised waves only contain waves oscillating along one axis.

Unpolarised waves can be oscillating in any direction perpendicular to the axis of propagation.

Describe how a ripple tank might be used to investigate diffraction.

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- Create water waves in the tank.
- Vary the size of the gap that they pass through.
- Note any changes to the direction of the waves passing through.

Polarised light is being passed through a rotating polarisation filter. What would happen to the intensity of the light passing through?

Polarised light is being passed through a rotating polarisation filter. What would happen to the intensity of the light passing through?

It would vary from a maximum (all light passes through) when the axis of polarisation and the axis of the filter line up, to a minimum (no light passes through) when the axes are perpendicular.

What is meant by the refractive index of a material? What equation can be used to find it?

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The refractive index is a measure of how fast light travels in a material compared to its speed in a vacuum.

It is found using: $n = c/v$

Where n = refractive index, c = speed of light, v = velocity in the material

A beam of light is shone at a boundary between air and glass. As the angle of incidence is increased from 0 to 90, what would you see?

A beam of light is shone at a boundary between air and glass. As the angle of incidence is increased from 0 to 90, what would you see?

- At 0° all of the light would pass into the material along the normal.
- The light would then be seen to be refracted (the angle to the normal in the glass would be larger than the incident angle).
- Eventually the light would bend so much it would start to be reflected back.

What is the name given to the angle of incidence at which light will reflect off a boundary rather than refracting in the medium?

What is the name given to the angle of incidence at which the light will reflect off a boundary rather than refracting in the medium?

The critical angle.

$$sinC = 1/n$$

Where C = critical angle, n = refractive index of the material being passed into.

What is the name given to what happens to light at angles greater than the critical angle?

What is the name given to what happens to light at angles greater than the critical angle?

Total internal reflection.

Waves can ‘superpose’ - what does this mean?

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Two waves in the same place (ie. one on top of the other) will combine.

What are the two types of interference?

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Constructive and destructive.

Describe an experiment to investigate the principle of superposition using sound.

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1. Use two speakers, a moderate distance apart, connected to the same signal generator to transmit sound waves.
2. Walk along a line perpendicular to the speakers - you should hear alternating loud and quiet points.
3. This is because in some places the waves from each speaker constructively interfere (loud) and in some places it's destructive.

Define coherence.

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Coherent waves have the same frequency and wavelength and a fixed phase difference (often zero in exam questions).

If two waves are in phase will they constructively or destructively interfere?

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Waves in phase will constructively interfere.

True or false? Path difference and phase difference are two names for the same thing.

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False.

Path difference is the difference in distance that two waves have travelled in terms of the wavelength (units of length).

Phase difference is the difference in the point in the cycle of two waves as a proportion of a full wave cycle (units of degrees/radians).

Why is a laser useful in showing interference and diffraction?

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It produces monochromatic (same wavelength/colour) light.

What is Young's double-slit experiment?

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A single source of light is directed towards a double slit, which creates two coherent beams of light. This interferes as it hits the screen and creates an interference pattern.

Describe the interference pattern created using white light.

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The interference pattern would be a repeating coloured spectrum along the screen, with a bright white point directly in front of the slit.

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

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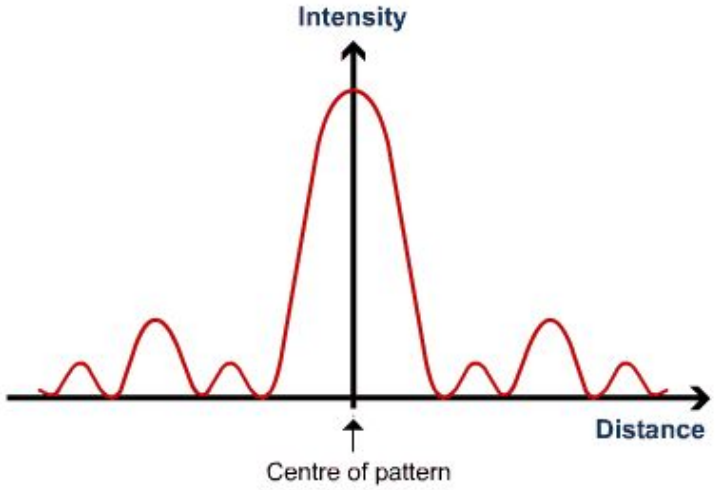
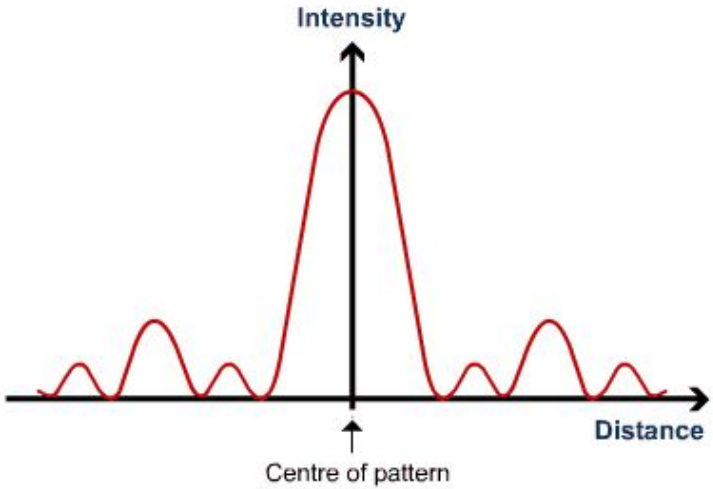
True.

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



https://www.s-cool.co.uk/a-level/physics/diffraction/revise-it/diffraction-interference-and-superposition

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



Single slit.

https://www.s-cool.co.uk/a-level/physics/diffraction/revise-it/diffraction-interference-and-superposition

What equation relates the wavelength of light to the slit spacing and the distance to the screen?

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$$\lambda = ax / D$$

Where λ = wavelength, a = slit spacing, x = fringe spacing (on screen), and D = distance to screen

Which two properties of light can only be explained if it is a wave?

Which two properties of light can only be explained if it is a wave?

1. Diffraction.
2. Interference (as seen in Young's experiments).

When shining light through a diffraction grating there is a maximum number of fringes that can be produced. How would you find this maximum number?

When shining light through a diffraction grating there is a maximum number of fringes that can be produced. How would you find this maximum number?

$$n\lambda = D\sin\theta$$

The maximum angle that would produce a fringe would be 89.9999999…. (so call it 90!).

Rearrange the equation for n, using $\theta=90$.

What is a stationary wave?

What is a stationary wave?

Stationary waves consist of an alternating fixed pattern of nodes (points with zero amplitude) and antinodes (points with maximum amplitude). No energy is transferred by the wave, it is only stored.

What is a node?

What is a node?

A point with no vibrations and at which the resultant amplitude is 0.

What is an antinode?

What is an antinode?

A point with maximum vibration and at which the resultant amplitude is at a maximum.

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 coherent.
- They must be travelling in opposite directions.

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

Give an example of an experiment that demonstrates stationary waves.

Give an example of an experiment that demonstrates stationary waves.

Use an oscillator to generate a wave along a string that is fixed at one end.

The stationary wave will form when the progressive wave is reflected off the fixed end.

Give a similarity and a difference between stationary waves and progressive waves.

Give a similarity and a difference between stationary waves and progressive waves.

Similarity: Both have a wavelength, frequency and amplitude.

Difference: Stationary waves don't transmit energy from one place to another.

How could you use the formation of stationary waves in a resonance tube to find the speed of sound?

How could you use the formation of stationary waves in a resonance tube to find the speed of sound?

- Create a closed end pipe using a hollow pipe inside a measuring cylinder containing water.
- Use a tuning fork (which produces a known frequency) and hold it above the tube.
- Move the tube up until you find the first position at which resonance occurs.
- This length will be a quarter of the wavelength.
- Use speed = frequency x wavelength.

What is meant by ‘harmonics’?

What is meant by ‘harmonics’?

Harmonics are points where the stationary wave form doesn’t change due to the waves in each direction reinforcing each other.

A stationary wave on a string is made to oscillate at its fundamental frequency (1st harmonic) - how many nodes and antinodes would you see?

A stationary wave on a string is made to oscillate at its fundamental frequency (1st harmonic) - how many nodes and antinodes would you see?

Nodes - 2 (1 at either end)

Antinodes - 1 (in the middle)