

Waves and optics

GRE · GRE Subject Test · GRE Physics

Two individually bright waves can cancel at a point if their phases oppose.

Prerequisites: 16, 17, 18, 31, 32, 33.

- Analyse wave superposition and interference
- Use diffraction, polarisation and optical imaging
- Relate phase, frequency and dispersion

Choose the system and model

Add wave amplitudes, then calculate intensity. Intensity is proportional to squared amplitude for the same medium.

Use the governing relation

A path difference gives phase difference $2\pi\Delta/\lambda$. Coherent sources need stable relative phase.

Apply the conditions

For a single slit, minima satisfy a $\sin \theta = m\lambda$ for nonzero integers m . A double slit has a different interference condition.

Check the conclusion

Geometric optics needs a stated sign convention. Wave effects matter when apertures are comparable to wavelength.

Worked method

Coherent waves have a stable phase difference. Add amplitudes before squaring.

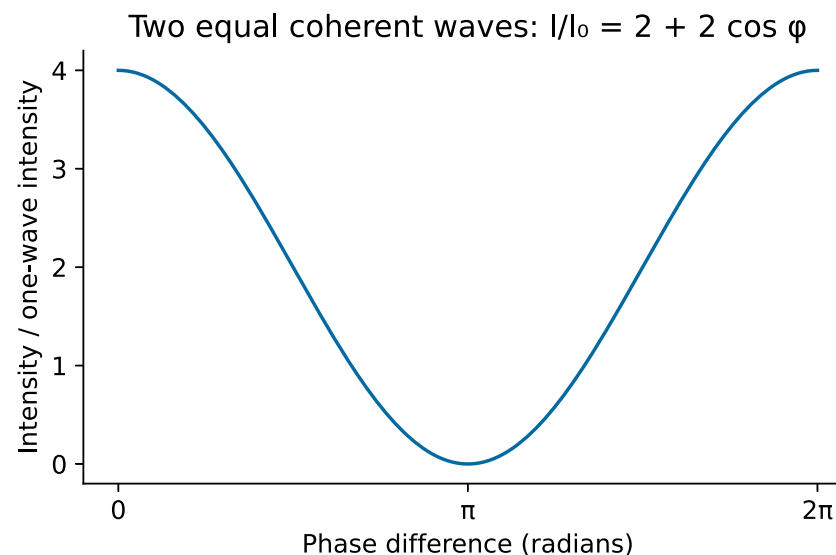
$$I = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos \delta.$$

For equal individual intensities I_0 and a path difference of one quarter wavelength,

$$\delta = 2\pi\Delta/\lambda = 2\pi(\lambda/4)/\lambda = \pi/2.$$

$$I = 2I_0(1 + \cos \delta) = 2I_0(1 + \cos(\pi/2)) = 2I_0.$$

This is neither a maximum nor a minimum. Random relative phase removes the cross term in a long time average; stable coherence is a physical condition, not a drawing convention.



Waves and optics: original GRE teaching diagram.

Check conditions and vocabulary

The central single-slit maximum is not obtained by setting $m=0$ in the minima condition.

coherence: A stable phase relationship between waves.

diffraction: Wave spreading and interference caused by an aperture or obstacle.