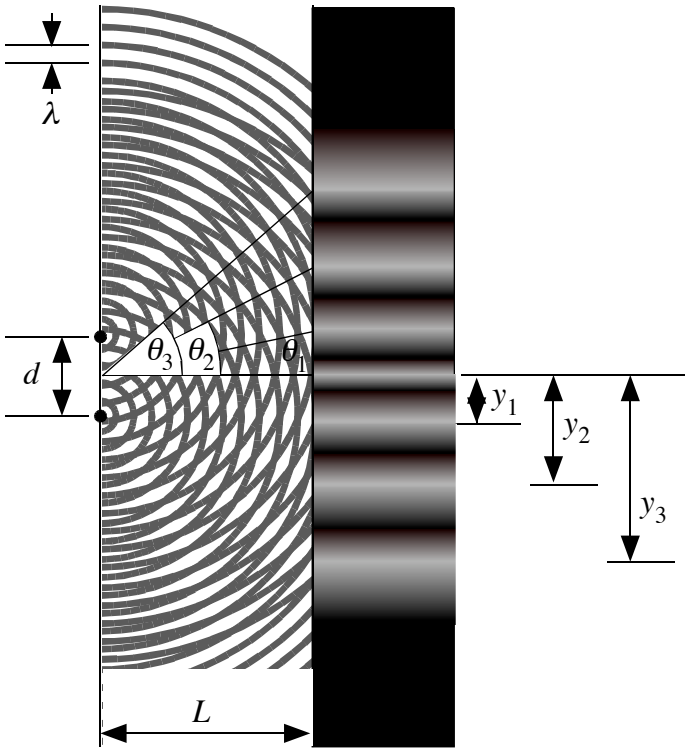
PhyzExamples: Wave Optics

Physical Quantities • Symbols • Units • Brief Definitions

Slit Separation • d • meters (m) • Light wavelength is the distance between successive electric field maxima or minima or magnetic field maxima or minima. These maxima and minima are those along the wave path (not maxima or minima of intensity on an interference pattern).
Slit to screen (or wall) distance • L • meters (m) • The distance between the sources and a screen or wall on which the resulting interference pattern is projected.
Wavelength • λ • meters (m) • The distance between two adjacent wave crests or troughs or compressions or rarefactions.
Mth Order Maxima Distance • y_m • meters (m) • The distance from the central maximum and the mth order maxima.
Mth Order Maxima Angle • θ_m • degrees (°) • The angle from the central maximum and the mth order maxima.
Order • m • unitless • In an interference or diffraction pattern, there is a series of bright and dark zones known as fringes. The order m indicates the position of a particular bright or dark fringe relative to the center of the pattern.



Equations

$m\lambda = d\sin\theta_m$ • Two-Slit Interference and Diffraction Grating Equation • *order of a particular maximum · wavelength of light used to generate the interference or diffraction pattern = separation distance between slits or lines in grating · sine of the angle at which the mth order maximum appears, as measured from the central maximum.*
$m\lambda = d\sin\theta_m$ • Single-Slit Diffraction Equation • *order of a particular **minimum** · wavelength of light used to generate the single-slit diffraction pattern =width of the single slit · sine of the angle at which the mth order **minimum** appears, as measured from the central maximum.*

Smooth Operations Examples

1. A two-slit interference pattern is produced using 632.8 nm light from a He-Ne laser.
a. If the angle between the central maximum and the 1st order maxima is 10°, what is the separation between the slits?

a. $\lambda = 632.8 \times 10^{-9}$ m $m = 1$ $\theta = 10°$ $d = ?$
$m\lambda = d\sin\theta$
$d = m\lambda/\sin\theta$
$d = 1 \cdot 632.8 \times 10^{-9}$ m / sin10°
$d = 3.64 \times 10^{-6}$ m = 3.64 μm

b. If second order maxima appear in the arrangement described in the previous problem, at what angle will they be found?

b. $\lambda = 632.8 \times 10^{-9}$ m $m = 2$
$d = 3.64 \times 10^{-6}$ m
$m\lambda = d\sin\theta$
$\theta = \sin^{-1}(m\lambda/d)$
$\theta = \sin^{-1}(2 \cdot 632.8 \times 10^{-9}\text{ m} / 3.64 \times 10^{-6}\text{ m})$
$\theta = 20.3°$