Physics of Waves

PH11003

Tutorial 9

Topic : Diffraction

20 January 2023

[9.1] Light with wavelength $\lambda = 0.50\ \mu m$ falls on a slit of width $b = 10\ \mu m$ at an angle $\theta_0 = 30^\circ$ to its normal. Find the angular position of the first minima located on both sides of the central Fraunhofer maximum.

[9.2] A plane light wave with wavelength $\lambda = 0.60\ \mu m$ falls normally on the face of a glass wedge with refracting angle $\theta = 15^\circ$. The opposite face of the wedge is opaque and has a slit of width $b = 10\ \mu m$ parallel to the edge. Find: (a) the angle $\Delta\theta$ between the direction to the Fraunhofer maximum of zeroth order and that of incident light; (b) the angular width of the Fraunhofer maximum of the zeroth order.

[9.3] A monochromatic beam falls on a reflection grating with period $d = 10\ mm$ at a glancing angle $\alpha_0 = 1.0^\circ$. When it is diffracted at a glancing angle $\alpha = 3.0^\circ$ a Fraunhofer maximum of second order occurs. Find the wavelength of light.

[9.4] Find the wavelength of monochromatic light falling normally on a diffraction grating with period $d = 2.2\ \mu m$ if the angle between the directions to the Fraunhofer maxima of the first and the second order is equal to $\Delta\theta = 15^\circ$.

[9.5] A transmission grating is expected to provide an ultimate first-order resolution of at least 1Å anywhere in the visible spectrum (400 to 700 nm). The ruled width of the grating is to be 2 cm. (a) Determine the minimum number of grooves required. (b) If the diffraction pattern is focused by a 50-cm lens, what is the linear separation of a 1-Å interval in the vicinity of 500 nm?
Answers:

[9.1] 33°and 27°
[9.2] (a) 7.9°, (b) 7.3°
[9.3] 0.6 μm

[9.4] 0.54 μm
[9.5] (a) 7000 , (b) 0.00175 cm