**Chapter-37**

1. Light of wavelength 540 nm passes through a slit of width 0.200 mm. (a) The width of the central maximum on a screen is 8.10 mm. How far is the screen from the slit? (b) Determine the width of the first bright fringe to the side of the central maximum.

Ans:

In a single slit diffraction pattern, with the slit having width *a*, the dark fringe of order *m* occurs at angle , where  and . The location, on a screen located distance *L* from the slit, of the dark fringe of order *m* (measured from *y* = 0 at the center of the central maximum) is



(a) The central maximum extends from the *m* = +1 dark fringe on one side to the *m* = –1 dark fringe on the other side, so the width of this central maximum is



Therefore,



(b) The first order bright fringe extends from the *m* = 1 dark fringe to the *m* = 2 dark fringe, or



Note that the width of the first order bright fringe is exactly one half the width of the central maximum.

1. Consider an array of parallel wires with uniform spacing of 1.30 cm between centers. In air at 20.0°C, ultrasound with a frequency of 37.2 kHz from a distant source is incident perpendicular to the array. (a) Find the number of directions on the other side of the array in which there is a maximum of intensity. (b) Find the angle for each of these directions relative to the direction of the incident beam.

Ans: The sound has wavelength  Each diffracted beam is described by 

The zero-order beam is at *m* = 0, *θ* = 0. The beams in the first order of interference are to the left and right at



For a second-order beam we would need



No angle, smaller or larger than 90°, has a sine greater than 1. Then a diffracted beam does not exist for the second order or any higher order. The whole answer is then:

(a) There are three beams.

(b) The beams are at 0°, +45.2°, –45.2°.

1. The first-order diffraction maximum is observed at 12.6° for a crystal having a spacing between planes of atoms of 0.250 nm. (a) What wavelength x-ray is used to observe this first-order pattern? (b) How many orders can be observed for this crystal at this wavelength?

Ans: (a) By Bragg’s law, , and *m* = 2:



(b) We obtain the number of orders from



The order-number must be an integer, so the largest value *m* can have is 4: four orders can be observed.