PHYS302 Fall 2023

Homework 1

(Problems from Hecht: 2.8, 2.39, 2.49, 2.54, 2.58; these are 1-5 below.)

1. It is possible to generate ultrasonic waves in crystals with wavelengths similar to those of light (5 x 10^-5 cm) but with lower frequencies (6 x 10^8 Hz). Compute the corresponding speed of such a wave.

2. Determine which of the following describe traveling waves:

    a. $\Psi\,(y,t) = e^{-(a^2y^2+b^2t^2-2abty)}$

    b. $\Psi\,(z,t) = A * \sin(az^2 - bt^2)$

    c. $\Psi\,(x,t) = A * \sin 2\pi(\frac{x}{a} + \frac{t}{b})^2$

    d. $\Psi\,(x,t) = A * \cos^2[2\pi(t - x)]$

    Where appropriate, draw the profile, and find the speed and direction of motion.

3. Show that eqns. (2.64) and (2.65) in the text, which are plane waves of arbitrary form, satisfy the three-dimensional differential wave equation.

4. Write an expression in Cartesian coordinates for a harmonic plane wave of amplitude A and frequency ω propagating in the positive x-direction.

5. Make up a table with the columns headed by values of ϴ running from -π/2 to 2π running in intervals of π/4. In each column, place the corresponding value of sin ϴ, and beneath those the values of sin (ϴ - π/2). Next add these together, column by column, to yield the corresponding values of the function sin ϴ + sin (ϴ – π/2). Plot each of these three functions, noting their amplitude and phase.