Course : B.Sc. (H) Physics – Semester II
Subject : Waves and Optics
Paper Code : 32221202

Practice Sheet

Books to be referred:

1) The Physics of Waves and Oscillations - N.K. Bajaj.
2) Vibrations and Waves, - A.P. French
3) The Physics of Vibrations and Waves - H. J. Pain
4) Waves - Berkeley Physics Course

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[1] A particle vibrates with SHM of amplitude 0.05 m and a period of 6 s. How long will it take to move from one end of its path to a position 0.025 m from the equilibrium position on the same side?

[2] A particle vibrates with SHM of amplitude 0.06 m and time period 31.4 s. Calculate its maximum velocity.

[3] A particle executes SHM with a time period of 2 s and an amplitude of 5 cm. Find its displacement and velocity after 1/3 s, starting from the mean position.

[4] A body is executing SHM and the equation is $x = a\sin(\omega t + \varphi)$. If the oscillations started from position x_0 with a velocity v_0, then show that the amplitude is given by,

$$a = \sqrt{{x_0}^2 + \left({v_0}/{\omega}\right)^2}$$

[5] A particle of mass 5 gram is executing SHM with amplitude 8 cm. If it makes 16 vibrations per second, then find its maximum velocity and energy at mean position.

[6] A particle is constrained to move along the x-axis. It is subjected to a force given by,

$$F = -kx + ax^3$$

Here, k and a are positive constants.
Draw the graph of potential energy of the particle as function of distance x from the origin.

[7] Using the vector representation, obtain the resultant motion of a particle subjected simultaneously to two simple harmonic motions in the same direction and having equal amplitudes and equal frequencies but a phase difference of $\pi/4$.

[8] Two collinear SHMs given below are acting on a particle simultaneously. Obtain the expression for the resultant motion (amplitude, phase constant and period of resultant vibration).

a) $x_1 = 0.3\cos 2\pi t$
$x_2 = 0.2\sin(2\pi t - \pi/3)$

b) $x_1 = 3\sin(20\pi t + \pi/6)$
$x_2 = 4\sin(20\pi t + \pi/3)$

[9] Find the frequency of the combined motion of each of the following.

a) $\sin(2\pi t - \pi/4) + \cos(2\pi t)$

b) $\sin(10\pi t) + \cos(11\pi t + \pi/4)$

c) $\cos(3t) - \sin(\pi t)$

d) $a\ \cos(2\pi\nu t) + b\ \sin(2\pi\nu t + \pi/3)$

e) $\sqrt{2}\sin 8\pi t + 2\sqrt{2}\cos 10\pi t$

[10] A particle is simultaneously subjected to three SHMs, all of the same frequency and in the same direction. If the amplitudes are 1 cm, 0.5 cm and 0.25 cm respectively, and the phase of the second relative to the first is 30°, and that of third relative to the second is 60°, then, find the amplitude of the resultant displacement and its phase relative to the first motion of amplitude 0.5 mm.

[11] Give the graphical representation for motion of a particle subjected to two perpendicular oscillations as given below.

a) $x = A\cos 2\omega t$
$y = A\sin 2\omega t$

b) $x = 5\cos 3\pi t$
$y = 3\cos(3\pi t + \pi)$

c) $x = 3\cos \omega t$
$y = 2\cos(2\omega t + \pi/2)$