Oscillations

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Assignment I

Q.1) In SHM, displacement is $x = asin(\omega t + \phi)$. At $t = 0, x = x_0$ with velocity v_0. Show that $a = \sqrt{x_0^2 + v_0^2/\omega^2}$ and $tan\phi = \omega x_0/v_0$.

Q.2) A particle is vibrated at frequency $5Hz$ in SHM. Show that when displacement exceeds $10^{-2} metre$, the particle loses contact with the vibrator. Given, $g = 9.8m/s^2$.

Q.3) In SHM, a particle has speed $80cm/sec$ and $60cm/sec$ with displacement $3cm$ and $4cm$. Calculate the amplitude of vibration.

Q.4) (a) If the length if a simple pendulum is increased by 44%, what is the percentage increase in its time period? (b) If a simple pendulum of frequency n is dropped with its support from a certain height above ground so that it falls freely under gravity, what will be the frequency of oscillation?

Q.5) (a) What fraction of the total energy is kinetic when in a SHM the displacement is half the amplitude? (b) At what displacement is the energy half kinetic and half potential?

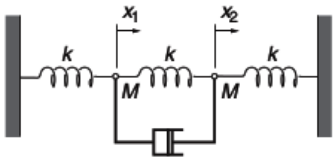
Q.6) Two simple harmonic motions are represented by the equations,

$$y_1 = 10sin(4\pi t + \frac{\pi}{4}), \texttt{and}, y_2 = 5(sin\ 3\pi t + \sqrt{3}\ cos\ 3\pi t).$$

Find the ratio of their amplitudes.

Q.7) (a) Light is reflected by a small mirror but not sound - also sound is reflected from a rough wall but not light. Why? (b) Is it necessary to have a medium for the transmission of sound or electromagnetic waves? Justify.

Q.8) In free space, two identical masses M are hung between three identical massless springs with spring constant k. The masses are connected to a dashpot of negligible mass that exerts a force bv, where v is the relative velocity of its two ends. x_1 and x_2 are the displacements of the two masses from equilibrium.



(a) Find the equation of motion for each mass. (b) Show that the equations can be solved in terms of the new dependent variables $y_1 = x_1 + x_2$ and $y_2 = x_1 x_2$. (c) Show that if the masses are initially at rest and mass 1 is given an initial velocity v_0, the motion of the masses after a sufficiently long time is $x_1 = x_2 = \frac{v_0}{2\omega} sin\omega t$. Evaluate ω.