PHY102 : Waves and Matter

Assignment - 1

This assignment will not be graded. You do not have to submit it. But you are encouraged to try out these and similar problems from any other source.

1. Do the following problems from the book "The physics of vibrations and waves" (6th edition) by H. J. Pain. Problem numbers : 1.2, 1.3, 1.5, 1.6, 1.10, 1.12, 1.15.

2. Starting from the equation of motion for a simple harmonic motion, show that the total energy of the system is a constant of motion.

3. A cylinder of mass m and cross-sectional area A floats upright in a fluid of density ρ. Take into account only the force due to buoyancy and show that if displaced from its equilibrium, the cylinder will execute simple harmonic motion vertically. Obtain an expression for the period of motion.

4. What is the period of oscillation of a mass of 40 kg on a spring with constant $k = 10N/m$?

5. A mass of 2 kg is attached to a spring with constant 18 N/m. It is then displaced to the point $x = 2$. How much time does it take for the block to travel to the point $x = 1$?

6. An oscillating system executes simple harmonic motion starting with $x(\pi/2) = 0$ and $\dot{x}(\pi/2) = v_0$. Write down the explicit solutions for $x(t)$ and $v(t)$ and sketch the solutions.

7. For the problem 6, write the total energy as a function of v_0.

8. For simple harmonic motion executed by a particle with total energy E with $x(t) = A\sin(\omega t + \phi)$, obtain an expression for the maximum velocity v_{max} of the particle.

9. A 0.5 kg mass is vibrating in a system in which the restoring constant is 100 N/m. The amplitude of vibration is 0.2 m. Find the energy of the system and the equation of motion if $x = A$ at $t = 0$.

10. A massless spring of constant K is hung vertically and not extended. A mass M is attached to the spring and it stretches a distance x_0. Find x_0 in terms of K, M and g.

11. A particle of mass M is executing simple harmonic motion. Obtain an expression for turning points as a function of the total energy E of the system. The turning points are those points in space at which the oscillatory motion changes directions.