United International University

School of Science and Engineering

Mid Term Examination; Year 2022; Trimester: Fall
Course: PHY 105/2105; Title: Physics; Sec: A-E
Full Marks: 30; Time: 1 Hour 45 Minutes

Questions no 1, 2 and 3 are mandatory to answer. Answer any one from question no 4 and 5.

1. (a) The displacement of a Simple Harmonic Motion (SHM) is $y = A\sin(\omega t + \frac{\pi}{2})$. Graphically show that the displacement and acceleration are out of phase to each other. — 2 CO1

   (b) Why do $\omega^2 > \gamma^2/4$ oscillatory? Draw displacement vs. time graphs for (i) $\omega/\gamma = 5$ and (ii) $\omega/\gamma = 0.005$. — 2 CO1

   (c) Graphically show that even though the potential and kinetic energies for Simple harmonic motion (SHM) vary with time, the total energy remains constant. — 2 CO

2. (a) A 4.0kg block extends a spring 16cm from its equilibrium position. The block is removed and a 0.5kg block is hung from the same spring. If the spring is stretched and released, what is the period of motion? — 3 C

   (b) Suppose the block has mass $m = 2.72 \times 10^5$ kg and is designed to oscillate at frequency $f = 10.0$ Hz and with amplitude A=20.0 cm. (i) What is the total energy E of the spring–block system? (ii) What is the KE and PE at x= 10cm (iii) At what position KE=PE? — 2 C

   (c) An oscillating block has kinetic energy equal to potential energy of 25J (KE=PE=25J) when the block is at $x = +0.50$ m. (i) what is the amplitude of oscillation? (ii) What is the kinetic energy when the block is at $x = 0$? — 3 C

3. (a) Find acceleration due to the Coulomb force between two 6 gm pennies one meter apart if we remove all the electrons from the aluminum ($^{26.98}_{13}Al$) atoms? Mass and charge of electron are $9.1X10^{-31}$ and $1.6X10^{-19}$ in SI unit, respectively. — 3

   (b) Draw an LRC series circuit using L= 0.4h, C = 0.0020μF components. What is the maximum resistance for which circuit will be oscillatory? — 2

   (c) An oscillator consists of a block attached to a spring (k =400 N/m). At some time t, the position, velocity, and acceleration of the block are x = 0.100 m, v=-13.6 m/s, and a=-123 m/s^2. Calculate (a) the mass of the block and (b) the amplitude of the motion. — 3

4. (a) Show that for a particle executing SHM, the instantaneous velocity is $\omega\sqrt{A^2 - x^2}$ and the maximum velocity is $\sqrt{2E/m}$, where symbols have their usual meanings. — 4

   (b) Show that the phase difference between acceleration and displacement of a body executing SHM is π and that of displacement and velocity is $\frac{\pi}{2}$.

5. (a) Derive the standing wave equation for the waves $y_{1,2} = A\sin(3\omega t \pm \frac{1}{2}kx)$, where symbols have their usual meanings, and find the distance where nodes and antinodes are most likely expected.

   (c) Derive the differential equation for RLC circuit and find out the condition for its oscillatory behavior. How the oscillation of the RLC circuit becomes that of an LC circuit?

CO1: Define different physical quantities with examples. CO2: Derive/Show the various equations of SHM, DHM, wave motion, e potential, etc. CO3: Evaluate different numerical problems based on the basic characteristics of SHM, DHM, electric charge, electric po etc.