KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
MAIN EXAM

FOR THE DEGREE OF B.Sc (PHYSICS)

COURSE CODE: SPC 212

COURSE TITLE: VIBRATIONS AND WAVES

DURATION: 2 HOURS

DATE: 22/12/2022 **TIME: 9:00-11:00AM**

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.

KIBU observes ZERO tolerance to examination cheating

QUESTION ONE [30 Marks]

a) Name two physical properties that causes to oscillate. [2]

b) Define Simple Harmonic Motion. [2]

c) The resultant force acting on a particle executing Simple harmonic motion is 4N when it is 5 cm away from the center of oscillation. Find the spring constant. [3]

d) Define the following terms as used in simple harmonic motion: [4]

i) Amplitude
ii) Frequency
iii) Phase
iv) Period

e) A particle of mass 40g executes a simple harmonic motion of amplitude 2.0 cm. If the period is 0.20s, find the total mechanical energy of the system. [4]

f) A light spring of a relaxed length a_0 is suspended from a point. It carries a mass at its lower free end which stretches it through a distance l. Show that the vertical oscillations of the system are simple harmonic in nature and have a time period, $T = 2\pi\sqrt{\frac{l}{g}}$. [5]

g) Diana goes to bed at 10:00 pm sharp every day. Is it an example of periodic motion? If yes, what is the time period? If no, why? Is it an example of simple harmonic motion? If yes, why? [4]

h) Show that the sine and cosine functions describing the displacement of the oscillating body executing simple harmonic motion are equivalent. [3]

i) A uniform rod of length 1m is suspended through an end and is set into oscillations with small amplitude under gravity. Calculate the time period of the oscillations. [4]

j) A uniform disc of radius 5.0 cm and mass 200g is fixed at its center to a metal wire, the other end of which is fixed with a clamp. The hanging disc is rotated about the wire through an angle and is released. If the disc makes torsional oscillations with time period 0.20s, find the torsional constant of the wire. [3]

QUESTION TWO [20 Marks]

a) A particle of mass 0.50 kg executes simple harmonic motion under a force $F = -(50\frac{N}{m})X$. If it crosses the center of oscillation with a speed of 10 m/s, find the amplitude of the motion. [4]

b) Consider a particle of mass m moving along the x-axis. Suppose, a force $F = -kX$ acts on the particle where k is a positive constant and X is the displacement of the particle from origin. If the particle executes simple harmonic motion with the center of oscillation at the origin, show that the

displacement and velocity at time t is given as $X = A\sin(\omega t + \delta))$ and $v = A\omega\cos(\omega t + \delta)$ respectively. [16]

QUESTION THREE [20 Marks]

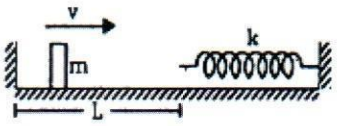
a) Using vector method, show that the resultant amplitude of two simple harmonic motions represented by $X_1 = A_1 \sin \omega t$ and $X_2 = A_2 \sin(\omega t + \delta)$ is given as

$A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2 \cos\delta}$ [4]

b) Find the amplitude of simple harmonic motion obtained by combining the motions

$X_1 = (2.0cm)\sin \omega t$ and $X_2 = (2.0cm)\sin\left(\omega t + \frac{\pi}{3}\right)$. [4]

c) Describe the motion of mass *m* shown. The walls and the block are elastic. [12]



QUESTION FOUR [20 Marks]

Obtain an expression for the displacement of the damped harmonic oscillator where the damping force is proportional to the velocity. Discuss the effect of the damping on the displacement and frequency of the oscillator.

[20]

QUESTION FIVE [20 Marks]

a) A small spherical steel ball is placed a little away from the center of a concave mirror whose radius of curvature is 2.5m. When the ball is released, it begins to oscillate about the center. What is the period of oscillation? Neglect friction and take g=10m/s^2. [4]

b) A simple pendulum of length 40cm oscillates with an angular amplitude of 0.04 rad. Find:
   i) The time period, [2]
   ii) The linear amplitude of the bob, [2]
   iii) The speed of the bob when the string makes 0.02 rad with vertical and, [2]
   iv) The angular acceleration when the bob is in momentary at rest. Take g=10m/s^2 . [2]

c) Two vibrations along the same line are described by the equations:
   $X_1 = 0.03\cos 10\pi t$ and $X_2 = 0.03\cos 12\pi t$.
   Obtain the equation describing the resultant motion and hence the beat period. [4]