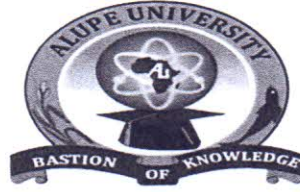


PHY 212



ALUPE UNIVERSITY

OFFICE OF THE DEPUTY VICE CHANCELLOR

ACADEMICS, RESEARCH AND STUDENTS AFFAIRS

UNIVERSITY EXAMINATIONS

2024/2025 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER REGULAR MAIN EXAMINATION

**FOR THE DEGREE OF BACHELOR OF
EDUCATION SCIENCE**

COURSE CODE: PHY 212

COURSE TITLE: OSCILLATIONS AND WAVES

DATE: 15th January 2025

TIME: 1100 - 1400

INSTRUCTION TO CANDIDATES

- SEE INSIDE

THIS PAPER CONSISTS OF 5 PRINTED PAGES

PLEASE TURN OVER

REGULAR MAIN EXAMINATION
PHY 212: OSCILLATIONS AND WAVES

STREAM: BED (Science)

DURATION: 3 Hours

INSTRUCTIONS TO CANDIDATES

- i. Answer **TWO** questions in section **A** and any other **THREE** questions in section **B**.
 ii. You may need to use the following constants

Molar mass of Helium 0.004 kg / mol Universal gas constant $R = 8.314 \text{ J / mol / K}$ Acceleration due to gravity $g = 9.8 \text{ m / s}^2$ Speed of sound in air $v = 340 \text{ m / s}$ **SECTION A (24 MARKS)****Question One (12 Marks)**

- a) List any four examples of vibrational motion (4 Marks)
 b) State the key features of vibrational motion (2 Marks)
 c) Distinguish between transverse and longitudinal waves (2 Marks)
 d) A steel wire 6 m long has a mass of 60g and is stretched with tension of 1000N. What is the speed of propagation of a transverse wave on this wire? (4 Marks)

Question Two (12 Marks)

- a) A particle of mass 2 kg has damping force whose magnitude is numerically equal to 8 times the instantaneous speed. The particle is also attracted along the x-axis towards the origin by a force whose magnitude is numerically equal to $8x$. If it is initially at rest ($t=0$) at $x = 20$ and $\frac{dx}{dt} = 0$.

Given that the general solution is of the form $x = e^{-2t} (A + Bt)$. Find

- i) the position of the particle at any time (4 Marks)
 ii) the velocity of the particle at any time (3 Marks)

- iii) Illustrate graphically the position of the particle as a function of time, hence describe the motion. (2 Marks)
- (b) A block of mass (m), on a horizontal frictionless table, is attached to a rigid support by a spring of spring constant (k). The horizontal oscillations of the system are simple harmonic in nature. Show that its period time is given by $T = 2\pi\sqrt{\frac{m}{k}}$. (3 Marks)

SECTION B (36 MARKS)

Question Three (12 Marks)

- a) State the condition under which diffraction will occur (2 Mark)
- b) State physical interpretation of the differential equation of LC circuit. (2 Marks)
- c) Given that the charge on the capacitor is $Q = Q_0 \cos(\omega t)$, show that the voltage across the inductor (V_L) is given by $V_L = \omega^2 LQ$. (4 Marks)
- d) What are standing waves and how are they produced (2 Marks)
- e) An LCR circuit has $L = 10mH$, $C = 1.0 \mu F$, and $R = 1 \Omega$. Determine angular frequency, ω that correspond to this oscillation. (2 Marks)

Question Four (12 Marks)

- a) List any three factors influencing the speed of propagation of transverse and longitudinal waves (3 Marks)
- b) A string has a linear mass density of $0.25kg/m$ and stretched with tension of $25N$. One end is given a sinusoidal motion with a frequency of $5Hz$ and amplitude of $0.01m$. At the time $t = 0$, the end has a zero displacement and moving in the positive y direction.
- Determine speed of propagation of the wave (2 Marks)
 - Find the amplitude of the wave (1 Mark)
 - Find the wave length (1 Marks)
 - Write a wave function describing this wave. (2 Marks)
- c) On the same graph show critically damped, over-damped and under damped body oscillations (3 Marks)

Question Five (12 Marks)

- a) What is a forced oscillation? (2 Marks)
- b) A man enters a tall tower. He needs to know the height of the tower, but darkness obscures the ceiling. He does note, however, that a long pendulum extends from the ceiling almost to the floor and that its period is 12 s. How tall is the tower? (3 Marks)
- c) Explain the term Beat in oscillation and waves (2 Marks)
- d) A train moving at a speed of 40 m/s sound its whistle, which has a frequency of 500 Hz . Determine the frequency heard by a stationary observer as the train approaches the observer. (5 Marks)

Question Six (12 Marks)

- a) A standing wave on a string is expressed as $y = 0.5 \sin \frac{\pi}{3} x \cos 40\pi t$
- What are the amplitude and frequency of the component waves whose superposition can give rise to these expressions. (4 Marks)
 - Find the velocity of the wave in 4 a(i) above (3 Marks)
- b) What is the meaning of quality factor or Q-value of damped harmonic oscillator (2 Marks)
- c) Deduce the expression $\frac{\text{energy stored in the system}}{\text{energy lost per cycle}} = \frac{Q}{2\pi}$ and state the two roles of quality factor. (3 Marks)

Question Seven (12 Marks)

- a) Two waves traveling in opposite directions produce a standing wave. The individual wave functions are: $y_1 = A \sin(kx - \omega t)$ and $y_2 = A \sin(kx + \omega t)$. Find the resultant wave function. (3 Marks)
- b) The displacement of the medium in a sound wave is given by the equation $Y_1 = A \cos(ax + bt)$. Where A, a and b are positive constants. Determine the wavelength and frequency of incident wave? (4 Marks)
- c) The equation of motion $m\ddot{x} = -kx$ applies directly to the system a pendulum of mass m , and length l . If the pendulum bob is displaced by a small angular displacement θ and displacement of m along the circle of length l is $l\theta$ (θ in radians), show that $\omega^2 = \frac{g}{l}$. (5 Marks)