



MAASAI MARA UNIVERSITY

**REGULAR UNIVERSITY EXAMINATIONS
2023/2024 ACADEMIC YEAR
SECOND YEAR SECOND SEMESTER**

**SCHOOL OF PURE, APPLIED AND HEALTHY
SCIENCES
BACHELOR OF SCIENCE AND BACHELOR OF
EDUCATION**

COURSE CODE: PHY 2211-1

COURSE TITLE: OSCILLATIONS AND WAVES

DATE: April 2024

TIME: 2HOURS

INSTRUCTIONS TO CANDIDATES

- **Question One is Compulsory**
- **Answer Any Other Two**

This paper consists of five printed pages. Please turn over.

Question one [20 Marks]

- (a) Solve the differential equation $\ddot{x} + x = 2\dot{x}$ with the initial conditions $x(0)=1; x(1)=0$ [4marks]
- (b) An un damped system consists of a mass weighing 50N and a spring of stiffness 4000 Nm⁻¹. It is acted upon by a harmonic force of amplitude 60N and a frequency of 6 Hz. Find:
- The displacement of the spring due to the weight of the mass [2marks]
 - The static displacement of the spring due to the maximum applied force [2marks]
 - The amplitude of the forced motion of the mass. [3marks]
- (c) Differentiate between interference and beat as used in waves and oscillation [2marks]
- (d) Define the following terms
- Angular frequency [2marks]
 - Amplitude of a wave [2marks]
- (e) A pendulum is observed to complete 23 full cycles in 58 seconds. Determine:
- The period and [3marks]
 - The frequency of the pendulum [2marks]
- (f) Which would have the highest frequency of vibration?
- Pendulum A: A 200 g mass attached to a 1.0 m length string
- Pendulum B: A 400 g mass attached to a 0.5 m length string [3marks]

QUESTION TWO [15 MARKS]

- (a) Consider a spring mass system. Let it be driven by a harmonic force F(t). Show that:
- the particular solution, x_p is given as [4marks]
$$x_p = X \sin \omega t$$
 - the amplitude ratio is given as [4marks]
$$\frac{X}{\delta_{st}} = \frac{1}{\left(1 - \frac{\omega^2}{\omega_n^2}\right)}$$
 - state the equation when the amplitude ratio is

(I) positive [2marks]

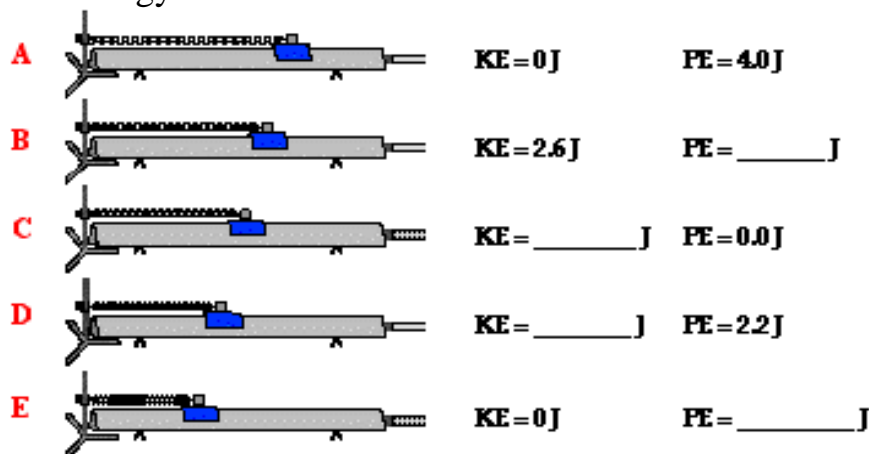
(b). State the law of conservation of energy [1marks]

(c) What do you understand by the term periodic motion as used in waves? [1marks]

(d) A pendulum is observed to complete 23 full cycles in 58 seconds. Determine its period. [3marks]

QUESTION THREE [15 MARKS]

(a) Use energy conservation to fill in the blanks in the following diagram. [4marks]



(b) State and explain three properties of waves [6marks]

(c) Nina wishes to make a simple pendulum that serves as a timing device. She plans to make it such that its period is 1.00 second. What length must the pendulum have? [4marks]

(d) Define the term doppler effects [1marks]

QUESTION FOUR [15 MARKS]

(a) A string vibrates according to the equation $y(x,t) = 0.5 \sin\left(\frac{\pi x}{3}\right) \cos 40\pi t$ where x and y are in centimetres and t is in seconds.

i. What are the amplitude? [4marks]

ii. and velocity of the component waves whose superposition can give rise to this vibration? [3marks]

iii. What is the distance between nodes? [3marks]

(b) A force of 16 N is required to stretch a spring a distance of 40 cm from its rest position. What force (in Newtons) is required to stretch the same spring

(i) Twice the distance? [2marks]

(ii) One-half the distance? [2marks]

(c) State the relationship between frequency and period of a simple harmonic motion. [1marks]