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**GARISSA UNIVERSITY**

**UNIVERSITY EXAMINATION 2019/2020 ACADEMIC YEAR TWO**

**SECOND SEMESTER EXAMINATION**

**SCHOOL OF PURE AND APPLIED SCIENCES**

**FOR THE DEGREE OF BACHELOR OF EDUCATION**

**COURSE CODE: PHY 212**

**COURSE TITLE: WAVES AND OSCILLATIONS**

**EXAMINATION DURATION: 2 HOURS**

**DATE: 14/02/2020 TIME: 2.00-4.00 PM**

**INSTRUCTION TO CANDIDATES**

* **The examination has FIVE (5) questions**
* **Question ONE (1) is COMPULSORY**
* **Choose any other TWO (2) questions from the remaining FOUR (4) questions**
* **Use sketch diagrams to illustrate your answer whenever necessary**
* **Do not carry mobile phones or any other written materials in examination room**
* **Do not write on this paper**

**This paper consists of FOUR (4) printed pages *please turn over***

**QUESTION ONE (COMPULSORY)**

1. State the superposition principle as used in wave phenomena **[1 mark]**
2. Show that the velocity of sound in a gas is given by $v=\sqrt{\frac{E}{P}}$ where E is the bulk modules and ρ is the density of the gas **[5 marks]**
3. Two identical piano strings of length 0.750 m are each tuned exactly to 440 Hz. The tension in one of the strings is then increased by 1.0%. If they are now struck, what is the beat frequency between the fundamentals of the two strings? **[6 marks]**
4. A 200-g block connected to a light spring for which the force constant is 5.00 N/m is free to oscillate on a horizontal, frictionless surface. The block is displaced 5.00 cm from equilibrium and released from rest, as in Figure below



1. Find the period of its motion **[4 marks]**
2. Determine the maximum speed of the block **[2 marks]**
3. What is the maximum acceleration of the block **[2 marks]**
4. A 0.500-kg cart connected to a light spring for which the force constant is 20.0 N/m oscillates on a horizontal, frictionless air track.
5. Calculate the total energy of the system and the maximum speed of the cart if the amplitude of the motion is 3.00 cm **[4 marks]**
6. What is the velocity of the cart when the position is 2.00 cm? **[3 marks]**
7. Compute the kinetic and potential energies of the system when the position is 2.00 cm **[3 marks]**

**QUESTION TWO**

1. A sinusoidal wave traveling in the positive *x* direction has amplitude of 15.0 cm, a wavelength of 40.0 cm, and a frequency of 8.00 Hz. The vertical position of an element of the medium at *t* = 0 and *x* = 0 is also 15.0 cm.



1. Find the wave number *k*, period *T*, angular frequency $ω$, and speed *v* of the wave. **[5 marks]**
2. Determine the phase constant $φ$, and write a general expression for the wave function **[5 marks]**
3. The variation in the gas pressure $ΔP$measured from the equilibrium value is also periodic. And can be expressed as $∆P=∆P\_{max}sin⁡(κx-ωt)$ **[10 marks]**

**QUESTION THREE**

1. A particle rotates counterclockwise in a circle of radius 3.00 m with a constant angular speed of 8.00 rad/s. At *t =* 0, the particle has an *x* coordinate of 2.00 m and is moving to the right
2. Determine the *x* coordinate as a function of time **[5 marks]**
3. Find the *x* components of the particle’s velocity and acceleration at any time *t* **[5 marks]**
4. The string is driven at a frequency of 5.00 Hz. The amplitude of the motion is 12.0 cm, and the wave speed is 20.0 m/s. Determine the angular frequency $ω$ and wave number *k* for this wave, and write an expression for the wave function **[5 marks]**
5. Show that the total mechanical energy of a simple harmonic oscillator is a constant of the motion and is proportional to the square of the amplitude **[5 marks]**

**QUESTION FOUR**

1. A laser in a compact disc player generates light that has a wavelength of 780 nm in air.
2. Find the speed of this light once it enters the plastic of a compact disc (*n* = 1.55) **[3 marks]**
3. What is the wavelength of this light in the plastic? **[3 marks]**
4. A submarine (sub A) travels through water at a speed of 8.00 m/s, emitting a sonar wave at a frequency of 1 400 Hz. The speed of sound in the water is 1 533 m/s. A second submarine (sub B) is located such that both submarines are traveling directly toward one another. The second submarine is moving at 9.00 m/s.
5. What frequency is detected by an observer riding on sub B as the subs approach each other? **[7 marks]**
6. As the two submarines recede from each other, the observer in sub B hears the frequency **[7 marks]**

**QUESTION FIVE**

1. An object oscillates with simple harmonic motion along the *x* axis. Its position varies with time according to the equation $x=(4m)cos\left(πt+\frac{π}{4}\right)$
2. Determine the amplitude, frequency, and period of the motion. **[4 marks]**
3. Calculate the velocity and acceleration of the object at any time *t*. **[4 marks]**
4. Consider a traveling wave propagating along a string that is under a tension *T*. Show that the differential equation called the linear wave equation is often written in the form $\frac{∂^{2}y}{∂x^{2}}=\frac{1}{v^{2}}\frac{∂^{2}y}{∂t^{2}}$ **[12 marks]**