# SPH 2173 Physics FOR Engineering I

Mechatronics engineering (Jomo Kenyatta University of Agriculture and Technology)

W1-2-60-1-6

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

**UNIVERSITY EXAMINATIONS 2021/2022**

**FIRST YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING, BACHELOR OF SCIENCE IN MECHATRONIC ENGINEERING, BACHELOR OF SCIENCE IN MARINE ENGINEERING AND BACHELOR OF SCIENCE IN AGRICULTURAL ENGINEERING**

**SPH 2173: PHYSICS FOR ENGINEERS I**

**DATE: DECEMBER 2021** **TIME: 2 HOURS**

**INSTRUCTIONS:**
Answer **Question One** and **any other two** questions
Question One is **COMPULSORY** and carries **30 marks**. The other questions carry **20 marks** each.
**START** each question on a **NEW PAGE.**

Use the following constants in answering questions:

*Acceleration due to gravity, g= 9.81 m/s².*
*1 Atm. = 1.013× 10⁵ N/m²*
*R=8.314J/mol.K (Universal gas constant)*
*Density of reservoir water=1000kg/m³*

## Question One

(a) (i) Distinguish between scalar and vector quantities and give one example of each. (3 marks)

(ii) Define fundamental and derived dimensions. (2 marks)

(ii) Check dimensionally the accuracy of the relation $s = ut + \frac{1}{2}at^2$, for the distance $s$ covered in time $t$ by a body having an initial velocity $u$ and acceleration $a$. (3 marks)

(b) (i) Distinguish between tangential and centripetal accelerations. (2 marks)

(ii) A 10-g metal bob attached to an inelastic string is whirled in a circular path of radius 15cm at an angular velocity of 5 rad/sec. Calculate the centripetal force experienced by the bob. (3 marks)

(c) Define simple harmonic motion and give one of its characteristics. (2 marks)

(d) For the specimen figure 1, show that Young's modulus $E = \frac{kl}{A}$, $k$ is stiffness constant of the specimen (3 Marks)

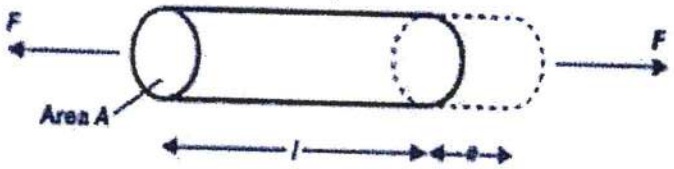


**Figure 1**

(e) Express 346.5 K in Rankine scales. (2 Marks)

(f) A wire of diameter 0.01 mm and length 1.2 m has been stretched by a 25 N force to a new length of 1.7 m. calculate the Young's Modulus of the wire. (3 Marks)

(g) A mass of 3.5 kg is gradually applied to the lower end of a vertical wire and produces an extension of 0.8 mm. Calculate;

(i) The energy stored in the wire. (2 Marks)

(ii) The loss in gravitational potential energy of the mass in loading. (2 Marks)

(h) Calculate applied force required to push a 30 kg mass with an acceleration of 5m/s2 on a horizontal surface with a coefficient of friction 0.3. (3 Marks)

## Question Two

(a) (i) Define the terms impulse and linear momentum. (2 marks)

(ii) Name the two physical quantities that are conserved in an elastic collision. (2 marks)

(b) A 3-kg object initially at rest explodes and splits into three fragments. One fragment has a a mass of 0.5kg and flies off along the negative x-axis at a speed of 2.8 m/s, and another that has a mass of 1.3 kg flies off along the negative y-axis at a speed of 1.5m/s. Determine the speed and direction of the third fragment. (6 marks)

(c) (i) Give five assumptions made in the derivation of the kinetic theory formula. (5 marks)

(ii) Show that $P = \frac{\rho \overline{C^2}}{3}$, where $P$ is pressure exerted on the surface of a container, ρ is the gas density and $\overline{C^2}$ is the mean square velocity of the gas molecules. (5 marks)

## Question Three

(a) (i) During material testing, a rod of diameter 10 mm and length 2 m was subjected to $2.0 \times 10^5$ N tensile force. The rod was deformed into a shape of diameter 7 mm and length 2.8 m. Calculate the Poisson's ratio obtained from the test. (5 Marks)

(ii) By considering a shaft, explain Torsion. (5 Marks)

(b) Give the qualitative explanation of the following;

(i) Conduction. (2 Marks)

(ii) Convection. (2 Marks)

(iii) Surface tension. (2 Marks)

(c) Explain two factors affecting surface tension in fluids. (4 Marks)

## Question Four

(a) (i) State any two of Kepler's laws planetary motion. (2 marks)

(ii) Explain briefly whether the value of acceleration due to gravity g is greater at the Equator than its value at the earth's North Pole. (2 marks)

(iii) Two bodies of masses $m_1 = 50$ kg and $m_2 = 0.25$ kg are separated by a distance of $r = 50$ m. If mass $m_2$ has a negligible radius while mass $m_1$ has a radius of $r = 0.5$ m, determine the gravitational force between them. (3 marks)

(b) A student throws an object with an initial velocity of $v_i = 100$ m/s at an angle of $\theta = 30°$ above the horizontal.

(i) Calculate the maximum height from the level from which it was thrown. (2 marks)

(ii) How far horizontally from the throwing point will the object attain its original level above the ground? (6 marks)

(c) A simple pendulum oscillates with SHM for small angles from the axis of swinging.

(i) Show that the period of oscillation is given by $T = 2\pi\sqrt{\frac{l}{g}}$. (4 marks)

(ii) What is period of oscillation if length of the pendulum is 5m. (1 marks)