



**EMBU UNIVERSITY COLLEGE**  
**(A CONSTITUENT COLLEGE OF THE UNIVERSITY OF NAIROBI)**

**FIRST SEMESTER EXAMINATIONS 2014/2015**  
**SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE**

**SPH 201: MECHANICS I**

**DATE: DECEMBER 11, 2014**

**TIME: 08:00 – 10:00AM**

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**INSTRUCTIONS:**

**Answer Question ONE and ANY Other TWO Questions.**

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**QUESTION ONE**

- a) State the three Keplers laws of planetary motion. (3 marks)
- b) State what is meant by length contraction and time dilation in the special relativity and give the equations governing the two phenomenons. (6 marks)
- c) State and briefly explain the three states of damping for an SHN. (6 marks)
- d) Differentiate between gravitational potential and gravitational field. (4 marks)
- e) A load of 50 N attached to a spring hanging vertically stretches the spring 5.0 cm. The spring is now placed horizontally on a table and stretched 11 cm. What force is required to stretch the spring by that amount? (4 marks)
- f) If an object–spring system is hung vertically and set into oscillation, why does the motion eventually stop? (2 marks)
- g) What is a geostationary satellite? State three applications of Earths’ geostationary satellites. (2 marks)

- h) State the difference between contact and field forces. To which category is gravitational field? (3 marks)

### **QUESTION TWO**

- a) A satellite of mass 200 kg is launched from a site on Earth's equator into an orbit 200 km above the surface of Earth.
- i) Assuming a circular orbit, what is the orbital period of this satellite? (5 marks)
  - ii) What are the satellite's tangential and angular velocities in its orbit? (5 marks)
  - iii) What is the minimum energy necessary to place the satellite in orbit, assuming no air friction? (5 marks)
  - iv) The gravitational force acting on it. (5 marks)

### **QUESTION THREE**

- a) A coin with a diameter of 2.40 cm is dropped on edge onto a horizontal surface. The coin starts out with an initial angular speed of 18.0 rad/s and rolls in a straight line without slipping. If the rotation slows with an angular acceleration of magnitude 1.90 rad/s<sup>2</sup>, how far does the coin roll before coming to rest? (8 marks)
- b) i) What is the tangential acceleration of a bug on the rim of a 10-in.-diameter disk if the disk moves from rest to an angular speed of 78 rev/min in 3.0 s?
- ii) When the disk is at its final speed, what is the tangential velocity of the bug?
- iii) One second after the bug starts from rest, what are its tangential acceleration, centripetal acceleration, and total acceleration? (12 marks)

### **QUESTION FOUR**

- a) i) Show that a potential difference of  $1.02 \times 10^6$  V would be sufficient to give an electron a speed equal to twice the speed of light if Newtonian mechanics remained valid at high speeds.
- ii) What speed would an electron actually acquire in falling through a potential difference of  $1.02 \times 10^6$  V? (10 marks)

- b) A spring in a toy gun has a spring constant of 9.80 N/m and can be compressed 20.0 cm beyond the equilibrium position. A 1.00-g pellet resting against the spring is propelled forward when the spring is released.
- Find the muzzle speed of the pellet.
  - If the pellet is fired horizontally from a height of 1.00 m above the floor, what is its range?  
(10 marks)

**QUESTION FIVE**

- Find the Fourier series of the function  $f(x) = x$  in the range  $-\pi < x \leq \pi$ . Hence show that  
 $1 - 1/3 + 1/5 - 1/7 + \dots = \pi/4$   
(12 marks)
- A spring stretches 3.9 cm when a 10-g object is hung from it. The object is replaced with a block of mass 25 g that oscillates in simple harmonic motion. Calculate the period of motion.  
(8 marks)

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