



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

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

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/s², 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 1.02×10^6 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 1.02×10^6 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
$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots = \frac{\pi}{4}$$

(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)

--END--