UNIVERSITY OF NAIROBI

SECOND YEAR EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE

SUPPLENTARY EXAMINATIONS 2010/2011

SPH 201: MECHANICS II

Date: **Time: 1 1/2 Hours**

- **This paper consists of five (5) Questions**
- **Attempt any THREE Questions**
- **The following devices are not allowed in the examination room: Mobile phones, IPods, BlueTooth or programmable calculators.**

Physical constants

Assume g = 10 ms^{-2}

Gravitational constant G = 6.7×10^{-11} Nm^2Kg^{-2}

Radius of Earth = 6,300Km

Mass of Earth = 5.96×10^{24} Kg

Question 1

(a) Discuss the following theories of relativity, stating the basis on which they were formulated and listing at least THREE predictions of each of the theories respectively

(i) Special Relativity

(ii) General Relativity. **[14 marks]**

(b) (i) A certain strain of bacteria doubles in number each 20 days. Two of these bacteria are placed on a spaceship and sent away from the earth for 1000 earth days. During this time, the speed of the ship was 0.995c. How many bacteria would be aboard when the ship lands on the earth?

(ii) Suppose the speed of light were 20ms^{-1}. Discuss how our lives would be changed. **[6 marks]**

Question 2

(a) List the essential features that are necessary for the establishment of oscillatory motion. **[3 marks]**

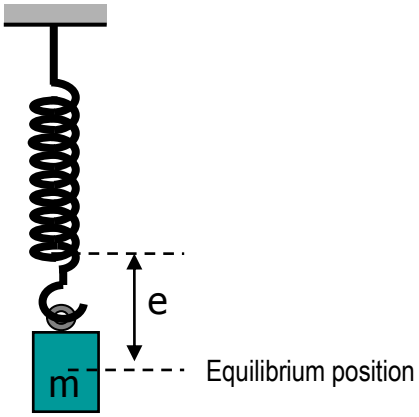
(b) A light helical spring of spring constant ***K*** hangs vertically from a fixed support and carries a mass ***m*** at its lower end. The mass is now displaced a

small distance in a vertical direction from its equilibrium position and released. Assuming that Hook's law is obeyed and there is no damping.

(i) Show that the subsequent motion is SHM.

(ii) Obtain an expression for the period ***T*** in terms of ***m*** and ***K***

(iii) If ***m*** = 0.30Kg and ***K*** = 30 Nm^{-1} and the initial displacement of the mass is 0.015 m, calculate the maximum kinetic energy of the mass



(iii) On the same axes, sketch graphs showing how the kinetic energy, potential energy and the tension in the spring vary with displacement from equilibrium positions. **[12 marks]**

(c) Two perpendicular vibrations are described by

$$x = 5\cos\ \omega t \qquad \text{and} \qquad y = 5\cos\left(\omega t + \frac{\pi}{4}\right)$$

Obtain the shape of the Lissajous figure of the combined motion.

[5 Marks]

Question 3

(a) The Copernican pedagogy on cosmology is more fundamental than Aristotelian. Adducing precise premises, elucidate the validity of this assertion. **[5 marks]**

(b) State and Explain TWO main legacies of Sir Isaac Newton that are fundamental to physics.

[5 marks]

(c) Using illustrations where possible, explain how the gravity of an object near the earth's surface is affected by the following factors

(i) Height above the earth's surface
(ii) Rotation of the Earth
(iii) Tidal forces. **[6 marks]**

(d) Explain TWO opportunities beneficial to mankind that can be accrued by taking advantage of lunar tides. **[4 marks]**

Question 4

(a) Explain with examples the characteristics of the following types of harmonic oscillators

(i) Damped harmonic oscillator

(ii) Forced harmonic oscillator **[4 marks]**

(b) A particle P of mass 2 moves along the x-axis attracted towards the origin by a force of magnitude 8x. If the particle has a damping force 8 times the instantaneous speed and if it is initially at rest at x = 20, find
(i) The differential equation of motion
(ii) The position and velocity of the particle at any time
(iii) The period and the amplitude of the motion
(ii) Illustrate graphically the position of the particle as function of time.
[8 marks]

(c) A vertical spring has a stiffness factor of 48Nm^{-2}. At $t = 0$, a force given by $f(t) = 120\cos 6t, \quad t \geq 0$ is applied to a 30N weight which hangs in equilibrium at the end of the spring. Neglecting damping, determine
(i) The position of the weight at any later time t
(ii) The natural frequency of the oscillation **[8 marks]**

Question 5

(a) Write short notes on the following
(i) Gravitational potential
(iii) Escape velocity
(iv) Geo-stationary satellites and their application beneficial to mankind.
[15 marks]

(b) Briefly explain how the US space exploration mission changed the way we view the world and our universe **[5 marks]**
