JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THEDEGREE OF BACHELOR OF SCIENCE

SOIL SCIENCE

1ST YEAR 1ST SEMESTER 2013/2014 ACADEMIC YEAR

MAIN

COURSE CODE: SPH 3111

COURSE TITLE: PHYSICS I

EXAM VENUE: WORKSHOP **STREAM: (SBPS)**

DATE: 17/04/14 **EXAM SESSION: 2.00 – 4.00 PM**

TIME: 2.00 HOURS

Instructions:

1. **Answer Question 1 (compulsory) and ANY other 2 questions**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

g=10 m/s^2

QUESTION ONE (30 MARKS)

(a) State Newton's law of gravitation (1 mark)

(b) A passenger on a Ferris wheel moves in a vertical circle of radius *R* with constant speed.

Assumingthat the seat remains upright during the motion, derive expressions for the magnitude of the upward forcethe seat exerts on the passenger at the top and bottom of the circle if the passenger's mass is *m*. (3 marks)

(c) An ultrasonic transducer (a kind of ultrasonic loudspeaker) used for medical diagnosis is oscillating at a frequency of 6.7 MHz. How much timedoes each oscillation take? (3 marks)

(d) Explain the Bernoulli's principle. (2 marks)

(e) A small elevator with a mass of 500 kg hangs from a steel cable that is 2.0 m long when not loaded. Thewires making up the cable have a total cross-sectional area of 0.3 cm^2 and with a 500 kg load, the cable stretches 0.50 cm beyond its unloaded length. Determine the cable's
(i) Stress (3 marks)
(ii) Strain. (3 marks)
(iii) Assuming that thecable is equivalent to a rod with the same cross-sectional area, determine the value ofYoung's modulus forthe cable's steel. (3 marks)

(f) Vector $\vec{A}$ has components A_X=1.30 cm, A_y=2.25 cm; vector $\vec{B}$ has components B_X=4.10 cm, B_y=-3.75 cm. Find

i) the components of the vector sum $\vec{A}+\vec{B}$ (3 marks)

ii) the magnitude and direction of $\vec{A}+\vec{B}$ (3 marks)

(g) A horizontal pipe of 20 cm^2 cross section carries water at a velocity of 2 m/s. The pipe feeds into a smaller pipe with a cross section of only 10 cm^2.What is the velocity of water in the smaller pipe?(3 marks)

(h) Explain the meaning of surface tension and state its S.I units (3 marks)

QUESTION TWO (20 MARKS)

(a) Suppose that, at any time *t*, the velocity vof a car is given by the equation $v_x = 50m/s + \left(0.4m/s^2\right)t^2$. In this equation, v_x has units of m/s and *t* has units of s.

(i) Find the change in velocity of the car in the time interval between $t_1 = 1s$ and $t_2 = 4s$ . . (2 marks)

(ii) Findthe average acceleration in this time interval. (2 marks)

(iii) Estimate the instantaneous acceleration at time $t_1 = 1s$ by taking $\Delta t = 0.1s$. (3 marks)

(b) A home-run baseball is hit with an initial speed V_0 = 30.0 m/s at an initial angle θ = 50^O

(i) Find the ball's position when time, t = 3 s (2 marks)

(ii) Find the magnitude and direction of its velocity when time, t= 3 s (3 marks)

(iii) Find the time when the ball reaches the highest point of its flight (2 marks)

(iv) Find the maximum height *h* the ball reaches. (3 marks)

(v) Find the range *R*. (3 marks)

QUESTION THREE (20 MARKS)

(a) You stand on a bathroom scale that rests on the floor of an elevator. Standing on the scale compresses internal springs and activates a dial that indicates your weight in newtons. When the elevator is at rest, the scale reads 650 N. Then the elevator begins to move upward with a constant acceleration $a_y = 3m/s^2$

(i) Determine your mass. (2 marks)

(ii) Determine the scale reading while the elevator is accelerating. (3 marks)

(iii) If you read the scale without realizing that the elevator is accelerating upward, what might you *think* your mass is? (1 mark)

(b) Two boxes are connected by a light string that passes over a light, frictionless pulley. One box rests on a frictionless ramp that rises at 30° above the horizontal (see Figure 1), and the system is released from rest.

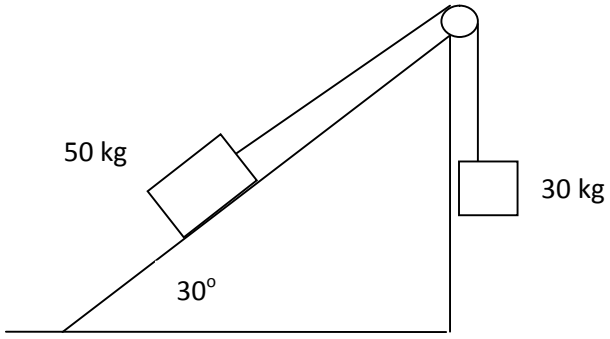

Figure 1

(i) Make free-body diagrams of each box. (4 marks)
(iii) Find the acceleration of each box. (4 marks)

(c)Find the tension in each cord in Figure 2 if the weight of the suspended object is 250 N. . (6 marks)

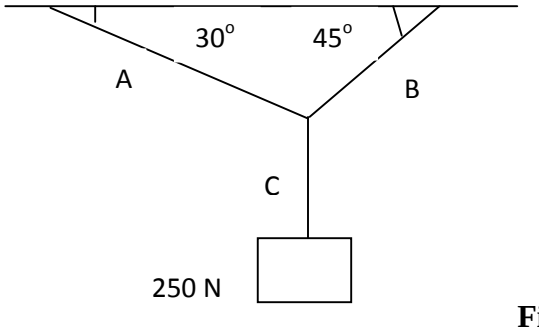

Figure 2

QUESTION FOUR (20 MARKS)

(a) Explain
(i) Zeroth Law of Thermodynamics (2 marks)
(ii) First Law of Thermodynamics (2 marks)

(b) During a bout with the flu, a 70 kg lady ran a fever of 3 ^{o}C; that is, his body temperature was 40 ^{O}C instead of the normal 37 ^{O}C. Assuming that the human body is mostly water, how much heat was required to raise his temperature by that amount? (3 marks)

(c) The Styrofoam cooler is used to keep drinks cold at a picnic. The total wall area (including the lid) is 1.2 m^2 and the wall thickness is 3.0 cm. The box is filled with ice and cans of Omni-Cola, keeping the inner surface at 0 ^{o}C. What is the rate of heat flow into the box if the temperature of the outside surface is 25 ^{O}C? (4 marks)

(d) A thin, square steel plate 20 cm on a side is heated in a blacksmith's forge to a temperature of 700 ^{o}C. If the emissivity is 0.60, what is the plate's rate of radiation of energy?
($\delta = 5.67 \times 10^{-8}$ W/(m^2.K)) (3 marks)

(e) State the assumptions made when stating kinetic theory of gases (4 marks)

(f) What is the average translational kinetic energy of a molecule of oxygen at a temperature of 30°C, assuming that oxygen can be treated as an ideal gas?
(Boltzmann constant $k = 1.381 \times 10^{-23}$ J/K) (2 marks)

QUESTION FIVE (20 MARKS)

(a) A bass violin withstrings has a length of 4.00 m between fixed points. One of the strings has a mass per unit length of 30 g/m and a fundamental frequency of 15.0 Hz.

(i) Calculate the tension in this string. (3 marks)
(ii) Calculate thefrequency and wavelength of the second harmonic. (6 marks)
(iii) Calculate the frequency and wavelength of the secondovertone. (6 marks)

(b) On a day when the speed of sound is 340 m/s the fundamental frequency of an open organpipe is 670 Hz.If the second *harmonic* of this pipe has the same wavelength as the second *overtone* of a stopped pipe, whatis the length of each pipe? (5 marks)