JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THEDEGREE OF BACHELOR OF EDUCATION (SCIENCE)

2ND YEAR 1ST SEMESTER 2013/2014 ACADEMIC YEAR

MAIN

COURSE CODE: SPH 201

COURSE TITLE: DYNAMICS

EXAM VENUE: LAB 6 **STREAM: (SBPS)**

DATE: 14/04/14 **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.**

QUESTION ONE (Compulsory) (30 marks)

a. A man ties one end of a strong rope 8 m long to the bumper of his truck, 0.5 m from the ground, and the other end to a vertical tree trunk at a height of 3.00 m. He uses the truck to create a tension of 800N in the rope. Compute the magnitude of the torque on the tree due to the tension in the rope, with the base of the tree acting as the reference point. (3 marks)

b. A uniform ladder 16 m long and weighing 80.0 N rests against a smooth vertical wall. If the ladder is just on the verge of slipping when it makes a 50˚ angle with the ground, find the coefficient of static friction between the ladder and ground. (3 marks)

b. 6 point objects each of mass 5kg, 7kg, 9kg, 10kg, 13kg, and 14 kg are distributed in a three dimensional space at the following respective coordinates: (0,2,4), (-3,-2,6), (1,1,1), (-2,-3,-4), (4,0,6) and (2,3,4). Determine the coordinates of the Centre of gravity of the system. (4 marks)

d. Show that the moment of inertia I of a thin spherical shell (hollow cylinder) of mass M and radius R is given by $I = \frac{2}{3}MR^2$ (5 marks)

e. A ball of mass *M* and radius *R* starts from rest at a height of 4.00 m androlls down a 40˚ slope, without slipping, determine the linear speed of the ballas it just leaves the incline. (3 marks)

f. Two bodies of masses m_1 and m_2 initially moving with velocities, u_1 and u_2 are involved in a perfectly inelastic collision. Show that the ratio of the total final kinetic energy to the total initial kinetic energy of the system is given by the equation

$$\frac{K_f}{K_i} = \frac{m_1}{m_1 + m_2}$$ (4 marks)

g. The nucleus of an atom has a mass of 3.80×10^{-25}kg and is at rest. The nucleus is radioactive and suddenly ejects a particle of mass 6.6×10^{-27} kg at a speed of 1.5×10^{7} m/s. Find the recoil velocity of the nucleus left behind. (3 marks)

h. Present the Galilean transformations giving a brief account of each. (5marks)

QUESTION TWO

a. A solid ball and a solid cylinder both of equal mass M and uniform radius R are placed side by side without touching each other up a smooth inclined plane of height 4m. The two are simultaneously released to roll freely down the incline. Which solid will win the race? (7 marks).

b. Two blocks with masses $\boldsymbol{m_1}$ and $\boldsymbol{m_2}$are attached by a string over a pulley of mass ***M*** as shown in figure 1. The pulley, which turns on a frictionless axle is a hollow cylinder (hoop) with radius ***r***over which the string moves without slipping. The horizontal

c. surface has coefficient of kinetic friction μ_k. The system is released such that m_2 falls through a vertical height h

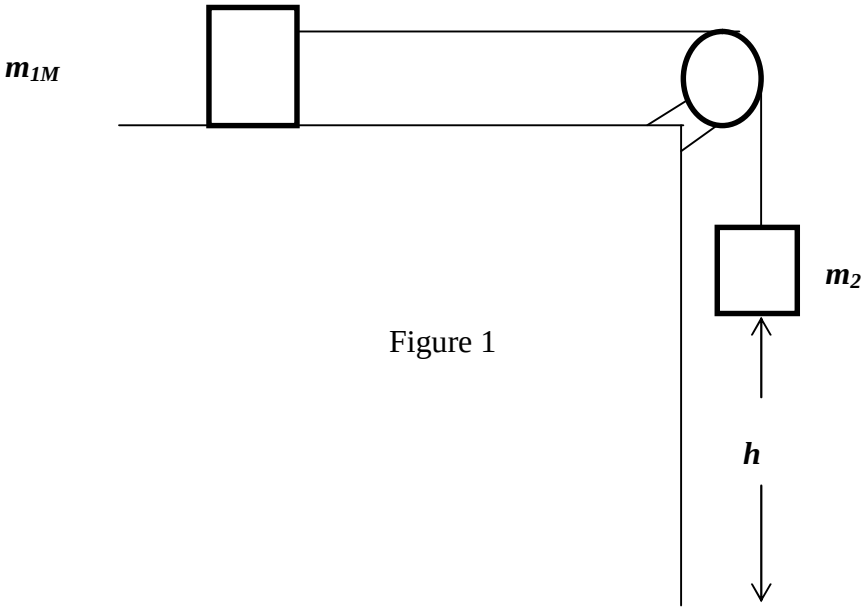

Figure 1

i. Show that the speed of the system when the mass m_2 falls through a vertical height h is given by

$$v = \sqrt{\frac{2gh(m_2 - «_k m_1)}{m_1 + m_2 + M}}$$ (9 marks)

ii. Given that $m_1 = 6kg$, $m_2 = 10\ kg$, $M = 2kg$, $\mu_k = 0.3$ and $r = 0.5m$, determine the rotational kinetic energy of the pulley and the translational kinetic energy of mass m_2 as the system falls through a vertical height of 4m. (4 marks)

QUESTION THREE

a. A 2,400 kg car traveling initially with a speed of 50.0 m/s in an easterly direction collides head on with a 9 000-kg truck moving in the western direction at 20.0 m/s. Given that the collision is perfectly elastic, determine the velocity of the each vehicle right after collision. (6 marks)

b. An 8 g bullet is fired at a velocity of 400m/s into a 5kg monkey suspended freely on a tree. The bullet gets embedded into the monkey and the two swing as a simple pendulum.

i. Determine the maximum height risen by the system from the rest position of the monkey. (4marks)

ii. Given that the bullet took 3 seconds to settle into the monkey's body, how deep did it penetrate into the monkey. (3 marks)

c. A car with mass 1800 kg traveling due east at a speed of 50 m/s collides at an intersection with a 2500-kg van traveling due north at a speed of 80m/s. Find the magnitude and direction of the velocity of the wreckage after the collision, assuming that the vehicles undergo a perfectly inelastic collision and assuming that friction between the vehicles and the road can be neglected. (7 marks)

QUESTION FOUR

a. Give a detailed account of Michelson-Morley experiment. (8 marks)

b. One airplane flies from point *O* to point *A* perpendicular to the direction of the wind, and the second airplane flies from point *O* to point *B* parallel to the wind. Given that they start at *O* at the same time, travel the same distance *L* with the same cruising speed *c* with respect to the wind, and return to *O*.
   i. Which airplane will win the race? (7 marks)
   ii. Show that the difference in their time flights is given by (5 marks)

$$\Delta t = \frac{Lv^2}{c^3} \text{ for } \frac{v}{c} \mapsto 0$$

QUESTION FIVE

a. Define the term reference frame. (2 marks)
b. Distinguish between inertial reference frame and non-inertial reference frame. (2 marks)
c. State the two postulates of relativistic mechanics (2 marks)
d. Distinguish between the coriolis and centrifugal forces (2 marks)
e. Bob's spacecraft is traveling at 0.6*c* in the positive *x*-direction, as measured by a nearby observer, while Mike is traveling in his own vehicle directly toward Bob in the negative *x*-direction at 0.8*c* relative the nearby observer. What's the velocity of Bob relative to Mike? (12 marks)