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 2016/17

MAIN REGULAR

COURSE CODE: SPH 201

COURSE TITLE: DYNAMICS

EXAM VENUE: PHY LAB **STREAM: (BED SCI)**

DATE: 06/09/16 **EXAM SESSION: 2.00 – 4.00 PM**

TIME: 2:00HRS

Instructions:

1. **Answer question 1 (Compulsory) in Section A and ANY other 2 questions in Section B.**
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 1

a. A uniform metre rule of mass 360 g is pivoted at 25 cm mark and at 85 cm mark. Three identical marbles each of masses 400 g are suspended at 15 cm, 60 cm and at 90 cm marks. Determine the reactions at the pivots (3 marks)

b. Consider the following mass distribution in the Cartesian plane 5 kg at (0, 0), 3 kg at (0, 4), and 4 kg at (3,0). Where should a fourth object of 8 kg be placed so that the center of gravity of the four-object arrangement will be at (2,2) (3 marks)

c. A 15.0-m, 500-N uniform ladder rests against a frictionless wall, making an angle of 60°. with the rough horizontal ground.

(i) Find the horizontal and vertical forces exerted on the base of the ladder by the Earth when an 800-N firefighter is 4.00 m from the bottom. (3 marks)

(ii) If the ladder is just on the verge of slipping when the firefighter is 9.00 m up, what is the coefficient of static friction between ladder and ground? (3 marks)

d. Two bodies with masses m_1 and m_2 moving at nitial velocities u_1 and u_2 respectively undergo a perfectly elastic collision. Their velocities after impact are v_1 and v_2 respectively. Show that

$$(u_1 - u_2) + (v_1 - v_2) = 0 \qquad \text{(4 marks)}$$

e. Calculate the net torque (magnitude and direction) on the beam in Figure 1.

i) When rotated about point O (3 marks)

ii) When rotated about point P (3 marks)

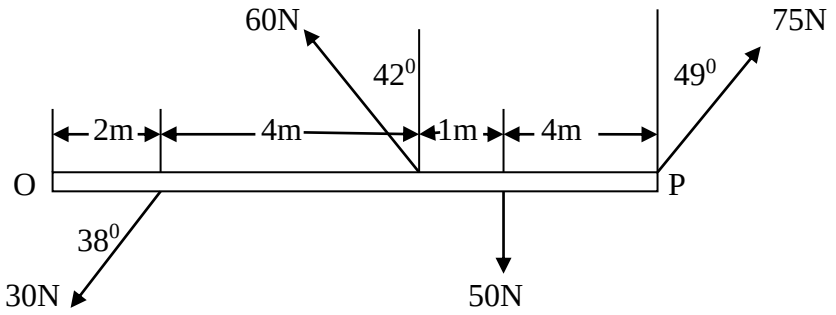

Figure 1

f. Show that a body of mass *m* rotating at an angular accelration α on a circle of radius r experiences a net torque given by $\sum \tau = I\alpha$, where I is the moment of inertia. (3 marks)

g. Define the term relativity (1 mark)

h. State the two postulates of relativity (2 marks)

i. Define the term frame of reference hence distinguish between inertial and non-inertial frames of reference (3 marks)

SECTION B

QUESTION 2

a. Define the following terms
   i. Torque (1 mark)
   ii. Centre of gravity (2 marks)

b. A uniform beam of weight 200N and length 6m is horizontally attached to a vertical wall by a pin that enables it to rotate. Its far end is supported by a cable that makes an angle of 60^{o} with the horizontal. A hungry 700-N monkey walks on the beam from the wall end towards the free end in an attempt to reach a 80N bunch of bananas that is freely suspended on the beam 1m away from the far end.

   i) Fnd the Tension in the wire and the Reaction force at the wall when the monkey is 3m away from the wall. (8 marks)
   ii) If the wire can withstand a maximum tension of 900 N, what is the maximum distance the bear can walk before the wire breaks? (4 marks)

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

QUESTION 3

a. A solid ball, a shell, a hoop and a solid cylinder all of equal mass M and uniform radius R are placed side by side without touching each other up a smooth inclined plane of height 6m. They are simultaneously released to roll freely down the incline. Determine the order in which they will leave the incline.
(10 marks).

b. A merry-go-round modeled as a disk of mass M =200 kg and radius R =5 m is rotating in a horizontal plane about a frictionless vertical axle. After a student with mass m =80.0 kg jumps onto the merry-go-round at the edge, the system's angular speed decreases to 4 rad/s. If the student walks slowly from the edge toward the center,

   i) find the angular speed of the system when she reaches a point 1.5 m from the edge. (3 marks)

ii) Find the change in the system's rotational kinetic energy caused by her movement to the center. (3 marks)

iii) Find the work done on the student as she walks to r = 1.5 m. (4 marks|)

QUESTION 4

a. Distinguish between elastic and inelastic collisions (2 marks)

b. Show that if two bodies m_1 and m_2 are involved in an inelastic collision, then their total initial Kinetic energy and their total final kinetic energy are related by the equation

$$K_f(m_1 + m_2) - K_i(m_1) = 0$$ **(**5 marks)

c. 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. (3marks)

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 90-kg motorbike moving towards North East with a speed of 50 m/s collides with a 100kg Tuk tuk moving towards South East at 30.0 m/s. If the collision is perfectly inelastic, calculate the velocity of the vessels just after the collision and the kinetic energy lost as a result of the collision. (7 marks)

QUESTION 5 (20 Marks)

a. Clearly Present the Galilean coordinate transformations (5 marks)

b. With well labeled diagram and clear equations of relativity, discuss the Morley-Michelson experiment. (8 marks)

c. Bob's spacecraft is traveling at 0.6c 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 0.8c relative to the nearby observer. What's the velocity of Bob relative to Mike? (5 marks)