JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE WITH IT

2ND YEAR 1ST SEMESTER 2018/2019 ACADEMIC YEAR

MAIN CAMPUS

COURSE CODE: SPH 210

COURSE TITLE: DYNAMICS

EXAM VENUE: **STREAM: (BED SCI.)**

DATE: **EXAM SESSION:**

TIME: 2 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

a. Calculate the magnitude and direction of the net torque on the beam in Figure 1.

   i) When rotated about point O **(3 marks)**

   ii) When rotated about point P **(3 marks)**

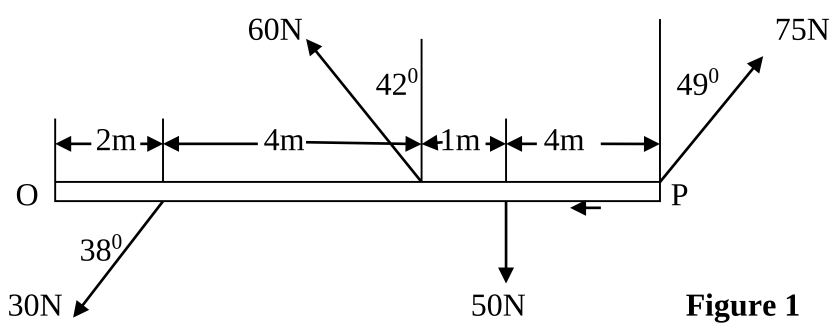

Figure 1

b. A uniform metre rule of mass 40g is supported by two pivots A and B each at 12cm mark and at 80cm mark respectively. Two identical point masses of 60g and 75g are suspended on the metre rule at 40cm mark and at 90cm mark respectively. Which pivot supports more weight and by how much. **(3 marks)**

c. A uniform ladder 18 m long and weighing 180.0 N rests against a smooth vertical wall. The coefficient of static friction between the ladder and ground is 0.42. The ladder makes a 53˚ angle with the wall. For how long will a mason climbing the ladder at 5m/s continue climbing before ladder begins to slip. **(3 marks)**

d. Two bodies with masses m_1 and m_2 moving at initial 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 $\frac{v_1 - v_2}{u_1 - u_2} = -1$ **(3 marks)**

e. An object consists of distributed particles each of mass ***m*** and rotates about an axis of radius ***r*** at a linear velocity ***v***. show that this object has a rotational kinetic energy given by $K.E = \frac{1}{2} I\omega^2$ **(3 marks)**

f. Show that the moment of inertia *I* of a thin spherical shell (hollow sphere) of mass M and radius R is given by $I = \frac{2}{3} MR^2$ **(4 marks)**

g. A solid sphere of mass *M* and radius *R* starts from rest at a height of 4.00 m and rolls down 50^0 slope without slipping. What is the linear speed of the ball when it leaves the incline? **(3 marks)**

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)**

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QUESTION TWO

a. A pulley made in the form of a solid sphere of mass M and radius R is used to draw water from a well of depth d. A bucket of mass m is attached to a rope that wraps around the pulley. The bucket is released to fall freely as the rope unwraps from the pulley.

i) Show that the acceleration of the bucket as it drops down the well is given by

$$a = \frac{mg}{m + \frac{2}{5}M}$$ **(4 marks)**

ii) Find the tension T and the acceleration a of the bucket given that ***m=4kg, M=10Kg and R=30cm*** **(3 marks)**

b. A solid ball, a solid cylinder, a hoop and a solid cylinder all of equal masses M and uniform radii 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. In which order will they leave the base of the incline? **(7 marks).**

c. 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 solid sphere with radius ***r*** over which the string moves without slipping. The horizontal surface has coefficient of kinetic friction $\boldsymbol{\mu_k}$. The system is released such that $\boldsymbol{m_2}$ falls through a vertical height ***h***

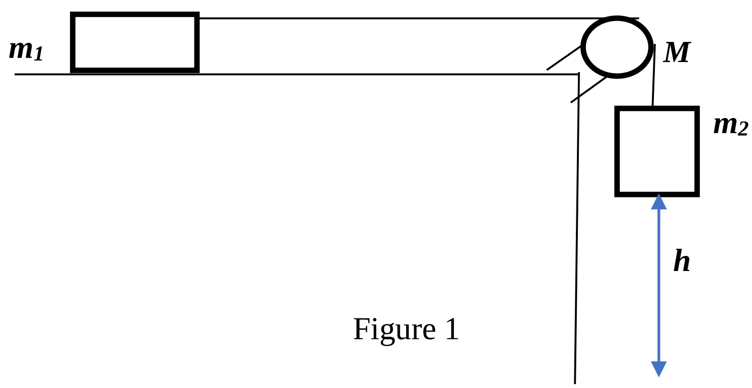

Figure 1

Show that the speed of the system when the mass m_2 falls through a vertical height h is given by $$v = \sqrt{\frac{10gh(m_2 - \mu_k m_1)}{5m_1 + 5m_2 + 2M}}$$ **(6 marks)**

QUESTION THREE

a. Show that if two bodies m_1 and m_2 are involved in an inelastic collision, then the ratio of their total initial Kinetic energy to their total final kinetic energy is given by the equation

$$\frac{k_f}{k_i} = \frac{m_1}{m_1 + m_2}$$ **(5 marks)**

b. A bullet of mass m_1 moving with initial speed v_1 collides inelastically with a block of mass m_2 that is suspended as a pendulum. After the collision, the block-bullet system rises to some height h. show that the initial velocity of the bullet is given as

$$v_1 = \frac{m_1 + m_2}{m_1}\sqrt{2gh}$$ **(6 marks)**

c. A 190-kg fullback player moving east with a speed of 50.0 m/s is tackled by a 210-kg opponent running north at 30.0 m/s. If the collision is perfectly inelastic, calculate

i) the velocity of the players just after the tackle and **(5 marks)**

ii) the kinetic energy lost as a result of the collision. Can you account for the missing energy? **(3 marks)**

QUESTION FOUR

a. State the principal of conservation of angular momentum. **(2 marks)**

b. A student sits on a pivoted stool that is free to rotate about a vertical circle. He is holding a pair of identical masses on each arm. The moment of inertia of the student, stool and weights is 4.0kgm^2. The student is set into rotation with arms outstretched making 600 revolutions per minute.

i. Determine the initial angular speed of the system. **(3 marks)**

ii. As he rotates, he pulls the weights inwards so that the new moment of inertia becomes 3.2 kgm^2. What is the new angular speed? **(3 marks)**

iii. Find the work done by student on the system while pulling the weights inwards **(4 marks)**

c. A small block on a frictionless horizontal surface has a mass of 0.0250 kg. It is attached to a massless cord passing through a hole in the surface. The block is originally revolving at a distance of 0.300 m from the hole with an angular speed of 1.75rad/sec. The cord is then pulled from below, shortening the radius of the circle in which the block revolves to 0.150 m.

   i) What is the initial angular momentum of the system? **(2 marks)**

   ii) What is the new angular momentum of the system? **(2 marks)**

   iii) Find the change in kinetic energy of the block. **(2 marks)**

   iv) How much work was done in pulling the cord? **(2 marks)**

QUESTION FIVE (20 Marks)

a. State the two postulates of general relativity. **(2 marks)**

b. Clearly Present the Galiliean coordinate transformations. **(7 marks)**

c. State the main objective of the Michelson-Morley experiment and with the aid of a diagram briefly describe the main experiment tool used. **(6 marks)**

d. An SGR train moving at a velocity of 300m/s overtakes a Mombasa-bound bus travelling at 120m/s. A train conductor collecting fares is walking from the rear seat towards the front seats of the train at 20m/s. what is the velocity of the train conductor relative to one of the passengers in the bus. **(5 marks)**