**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES**

**UNIVERSITY EXAMINATION FOR THEDEGREE OF BACHELOR OF EDUCATION (SCIENCE)**

**1ST YEAR 1ST SEMESTER 2013/2014 ACADEMIC YEAR**

# MAIN

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**COURSE CODE: SPH 101**

**COURSE TITLE: MECHANICS**

**EXAM VENUE: LAB 4** **STREAM: (SBPS)**

**DATE: 14/04/14** **EXAM SESSION: 9.00 – 11.00 AM**

**TIME: 2.00 HOURS**

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## 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.**

**IMPORTANT CONSTANTS:**
Universal gravitational constant G = $6.67 \times 10^{-11}$ $Nm^2/kg$
Radius of the earth R = 6380 km
Mass of the earth M = $5.98 \times 10^{24}$ kg
Acceleration due to gravity = 9.81 $m/s^2$

**SECTION A:**

1. a) Define the following;
(i) Mole (1 mark)
(ii) ampere (1 mark)

b) Using dimensional analysis, verify whether or not the formula $v = v_0 + \frac{1}{2} at^2$ is correct. All parameters have their usual meaning.
. ( 3 marks)

c) A ball is thrown vertically upwards from a point 0.5 m above ground level with speed of 7 m/s. Find the height above this point reached by the ball and the speed with which it hits the ground. (4 marks)

d) (i) State and derive the *work- energy theorem***.** (4 marks)
(ii) A small box of mass 0.2 kg revolves uniformly in a circle on a frictionless horizontal surface. It is attached by a cord 0.2 m long to a pin set in the surface. If the body makes two complete revolutions per second, find the force exerted on it by the cord. (3 marks)

e) Show that, according to Kepler, the square of the period T of revolution of a planet is proportional to the cube of its distance r from the sun i.e
$T^2 \alpha r^3$ (4 marks)

f) An electric motor rotates at 3600 rpm and a section of the wire on the armature is located 5 cm from the axis of rotation. Find the magnitude of centripetal acceleration of this piece of wire. (4 marks)

g) (i) Show that the maximum height $h_m$ reached by a projectile launched at an angle $\theta$ is given by $h_m = u^2 \sin^2\theta / 2g$, where all parameters have their usual meanings. (4 marks)

(ii) Define the term *coefficient of restitution*. (2 marks)

**SECTION B:** Attempt **ONLY TWO** questions from this section.

2. a) The centre of mass of a 10 kg mass is located 3 m away from the centre of mass of an 8 kg mass.
(i) Compute the magnitude of the gravitational force that the 10 kg mass exerts on the 8 kg mass. (2 marks)

(ii) Compute the magnitude of the gravitational force that the 8 kg mass exerts on the 10 kg mass. (2 marks)

(iii) In the absence of any other forces, find the acceleration of the 10 kg mass. (2 marks)

(iv) In the absence of any other forces, find the acceleration of the 8 kg mass. **(**2 marks)

b) A particle whose speed is 50m/s moves along a line from A(2,1) to B(9,25). Find its velocity vector. (3 marks)

c) (i) Derive the four equations of linear, uniformly accelerated motion. (7 marks)
(ii) Obtain the dimensions of energy. (2 marks)

3. a) A block is supported by strings as shown in figure 1. What are the tensions T, T1 and T2 in the strings, assuming the block is in equilibrium. (7 marks)

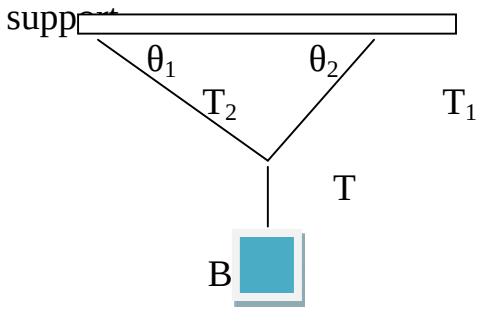


**Fig.1**

It is given that $\theta_1 = 30^0$ and $\theta_2 = 60^0$

b) (i) State four major characteristics of frictional force. (4 marks)
(ii) Object 1 in figure 2 weighs 100 N, $\theta = 30^0$,and the coefficient of static friction is 0.5 between it and the incline surface. Find the maximum weight of object 2 that will prevent object 1from sliding down the incline.(7 marks)

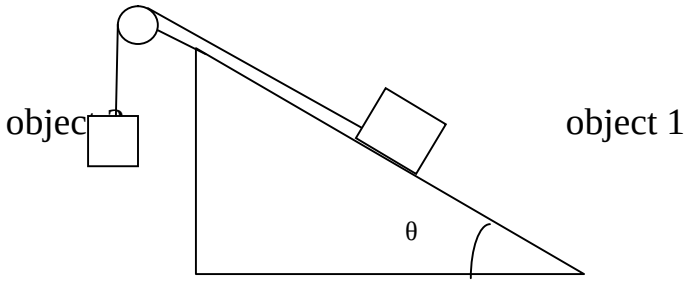


**Fig.2**

(iii) State the *principle of conservation of energy*. (2 marks)

4. a) (i) Consider a vehicle of mass *m* traveling at speed *v* round a bend of radius r on a road banked at an angle $\theta$. What is the speed at which a car can travel round this bend without skidding? (4 marks)
(ii) A car traveling at 28m/s has no tendency of slipping on a track of radius 200 m banked at an angle θ. When the speed is increased to 35 m/s, the car is just at the point of slipping off the track. Calculate the coefficient of friction $\mu$ between the car and the track. (6 marks)

b) (i) Figure 3 shows a particle projected up an inclined plane with an initial speed *u* at an angle $\alpha$ to the inclined plane. Show that the maximum range $R_m = u^2/g(1+sin\beta)$. (8 marks)

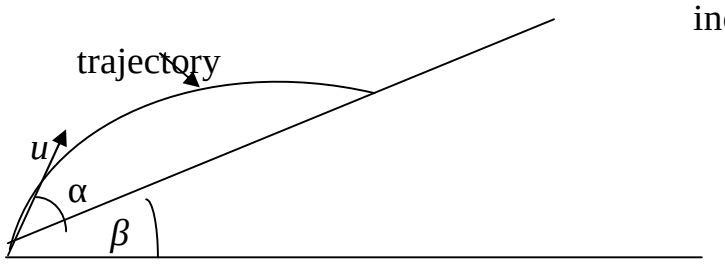


**Fig.3**

horizontal plane
(ii) State Hooke's law for a spring. (2 marks)

4. a) (i) Consider two smooth spheres of mass $m_1$ and $m_2$ moving along a straight path with velocities $u_1$ and $u_2$ respectively. If the final velocities.

5. after an elastic collision are $v_1$ and $v_2$ respectively, show that the final velocity of mass $m_1$ is given as $v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \left(\frac{2m_2}{m_1 + m_2}\right)u_2$

(8 marks)

(ii) State the *principle of conservation of momentum*. (2 marks)

b) Suppose you want to place a communication satellite into a circular orbit 300 km above the earth's surface, what must be its speed, period and radial acceleration? (6 marks)

c) Using Newton's law of universal gravitation, obtain the density of the earth. (4 marks)