KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF BSC (PHYSICS) AND B.ED (SCIENCE)

COURSE CODE: SPH 212

COURSE TITLE: CLASSICAL MECHANICS I

DURATION: 2 HOURS

DATE: 09/10/2018 **TIME: 11:30-1:30PM**

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **4** printed pages. Please Turn Over

KIBU observes ZERO tolerance to examination cheating

QUESTION ONE

(a) What do you understand by the term "frame of reference"? (2 marks)

(b) A particle of mass moves in space under the influence of a force field F. assume that at the time t_1 and t_2 the velocity is v_1 and v_2 respectively, Prove that the work done is the change in kinetic energy, i.e $\int_{t_1}^{t_2} F \cdot dr = \frac{1}{2}mv_1^2 - \frac{1}{2}mv_2^2$. (4marks)

(c) (i) What is the physical meaning of the center of mass of a many-particle system? (2marks)

(ii) Show that the Theorem of Perpendicular Axis is mathematical given by $I_z = I_x + I_y$

(4marks)

(d) (i) Define the terms gravitational force, gravitational field and gravitational potential?

(3marks)

(ii) Prove that $GM = gR^2$ where M is the mass of the earth and R is its radius.

(3marks)

(e) Find the work done in moving an object along a vector $r = 3i + 2j - 5k$ if the applied force is $F = 2i - j - k$. (4marks)

(f) Show that the force field F defined by $F = (y^2z^3 - 6xz^2)i + 2xyz^3j + (3xy^2z^2 - 6x^2z)k$ is a conservative force field. (4 marks)

(g) Prove the work energy theorem (4marks)

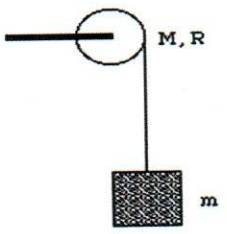
QUESTION TWO

(a) An object is projected vertically upwards from the earth's surface with initial speed v_0. Neglecting air resistance ,find

(i) the speed at a distance H above the earth's surface and (6 marks)

(ii) the smallest velocity of projection needed in order that the object never return. (2 marks)

(b) Figure below shows a uniform disk with mass M and radius R. The disk is mounted on a fixed axle. A block with mass m hangs from a light cord that is wrapped around the rim of the disk. Find the acceleration of the falling block, the angular acceleration of the disk, and the tension of the cord. (12 marks)



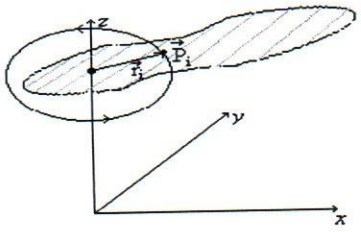
QUESTION THREE

(a) Show that $F = (2xy + z^3)i + x^2j + 3xz^2k$ is a conservative force field. (4 marks)

(b)(i) Find the potential in (a) (4 marks)

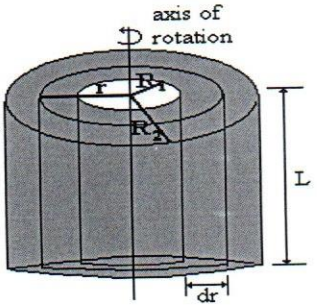
(ii) the work done in moving an object in this field from (1,-2,1) to (3,1,4) (2 marks)

(c) Consider a rigid body rotating with angular velocity ω about an axis that is fixed in an inertial frame of reference as shown in the figure. Derive an expression of the total kinetic energy of this rotating body. (10 marks)



QUESTION FOUR

(a) Show that the moment of inertia of annular cylinder shown below is given by $I = \frac{1}{2}M\left(R_2^{\,2} + R_1^{\,2}\right)$. (5 marks)



(b) Consider a disc of mass M and radius R rolling down an inclined plane without slipping. Show that the speed of its center of mass when it reaches the bottom of the incline is $\sqrt{\frac{4}{3}gh}$ (5 marks)

(c) State and prove the theorem of parallel axis (10 marks)

QUESTION FIVE

a) Let $\vec{r}_v'$ and $\vec{v}_v'$ be respectively the position vector and velocity of a particle v relative to the center of mass. Prove that (a) $\sum_v m_v \vec{r}_v' = 0$, (b) $\sum_v m_v \vec{v}_v' = 0$ (6 marks).

b) A block of mass M shown in the figure initially has velocity v_o to the right, and its initial position is such that the spring exerts no force on it, i.e. the spring is neither stretched nor compressed. The block moves to the right a distance l before it stops. If k is the spring constant, and μ_k is the coefficient of kinetic friction between the block and the surface,

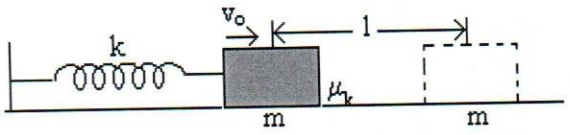
i. What is the work done on the block by the frictional force? (2 marks)

ii. What is the work done on it by the spring force? (2 marks)

iii. Are there some other forces working on the block, what work do they do? (2 marks)

iv. What is the total work done on the block? (2 marks)

v. Using work-energy calculate the value of l in terms of m, v_o, μ_k, g, k. (2 marks)



c) (i) Define the following terms: Isobaric process and irreversible process (2 marks)

(ii) State both the first and second laws of thermodynamics (2 marks)