CHUKA UNIVERSITY

UNIVERSITY EXAMINATION

FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE PHYSICS &(GENERAL), BACHELOR OF EDUCATION (SCIENCE) & BACHEOR OF SCIENCE COMPUTER SCIENCE & APPLIED COMPUTER SCIENCE

PHYS 13I: MECHANICS 1

STREAMS: BSc. (PHY &GEN), B Ed. (SCIENCE), BSc. (COMP SC & APPLIED) Y1S1

TIME: 2 HOURS

DAY/DATE:THURSDAY 13/12/2018 **2.30 P.M – 4.30 P.M**

INSTRUCTIONS:

- Attempt question ONE (30 marks) and any other TWO questions (20 marks each).
- Start each question on a fresh page

USEFUL CONSTANTS

- g = 10 m/s^2
- G = 6.672 $\times 10^{-11} Nm^2/kg^2$

QUESTION ONE

a. State Newton's First Law of Motion (1 mark)

b. State the two classes of Physical quantities giving an example of each (2 marks)

c. List the two conditions for mechanical equilibrium of a body for which the forces acting lie in the X-Y plane. (2 marks)

d. Given two vectors **Y = i + 2j – 6k** and **R = 3i +5j + 4k**.

e. Determine:- (i) Y x R (4 marks)

(ii) $Y \cdot R$ (3 marks)

f. In the gas equation, $\left(P+\frac{a}{V^2}\right)(V-b)=RT$, find the dimensions of the constants:-

i. a (4 marks)

ii. b (2 marks)

g. The position of a particle is given by $r=A\left(e^{\alpha t}i+e^{-\alpha t}j\right)$, where A and α are constants. Determine the velocity of the particle. (3 marks)

h. State ***Kepler's Laws*** of planetary motion. (3 marks)

i. State the law of conservation of momentum for a system of particles (2 marks)

j. Distinguish between elastic and inelastic collision (4marks)

QUESTION TWO

a). Distinguish between angular displacement and angular velocity. (4 marks)

b). Show that the relationship between angular velocity and linear velocity is given by $V=r\omega$.

(5marks)

c). A pendulum bob of mass 50g is attached to one end of a string of length 1.5m. The bob moves in a horizontal circle in such a way that the string is inclined at 10^o to the vertical. Calculate the:-

(i) tension in the string. (4 marks)

(ii) period of the motion. (3 marks)

d). Consider a block of mass m_1 resting on a flat rough surface of coefficient of friction μ . Mass m_2, is connected to mass m_1 by means of a massless and inextensible cord over a frictionless pulley. Show that the acceleration of the masses is given by:

$$a=\left(\frac{m_2-\mu m_1}{m_1+m_2}\right)g$$

(4 marks)

QUESTION THREE

a. A force **F** acts on an object of mass m. If the mass m accelerates uniformly from rest, to a velocity v ms^{-1}, over a distance s, derive an expression that relates the work done in changing the kinetic energy of the mass. (5 marks)

b. A car of mass 1 x 10^3 kg traveling at 72 km/h on a horizontal road is brought to rest a distance of 40 m by the action of brakes and frictional forces. Determine:-

a. Work done in stopping the car (5 marks)

b. The braking force. (3 marks)

c. A man of 80 kg climbs up a slope 400m long inclined at 5° to the horizontal.

i. Sketch a diagram representing the motion of the man. (2 marks)

ii. Calculate the minimum work done by the man. (5marks)

QUESTION FOUR

a. Distinguish between the centre of mass and center of gravity of an object. (4 marks)

b. Show that the position vector **R** for the center of mass of an object formed by i particles each of mass m can be expressed as:- (6 marks)

$$R=\frac{\sum miri}{M}$$

c. Two bodies of masses 2 kg and 10 kg have position vectors (3**i**+2**j**-**k**) and (**i**-**j**+3**k**) respectively. Find the:-

i. position vector of the centre of mass (5 marks)

ii. distance of the centre of mass from the origin (5 marks)

QUESTION FIVE

a. A block of mass m =3.5 Kg is pushed up a rough inclined plane of angle $\theta = 30^0$ with an initial speed u =4.8 ms^{-1}. It travels a distance d =1.6m up the incline, comes momentarily to rest and slides back down to the bottom of the incline.

i. Determine the magnitude of the frictional force F_r acting on the block during its motion. (4 marks)

ii. Calculate the speed of the block when it reaches the bottom of the incline. (4 marks)

b. A projectile is launched with an initial speed of u m/s and at an angle θ to the horizontal. Obtain an expression for :-

i. the time it takes to reach the highest point (4 marks)

ii. the highest point reached. (4marks)

c. Prove that the range of the projectile is a maximum when angle θ = 45 °. (4 marks)
