(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2017/2018 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER

SPECIAL/ SUPPLEMENTARY EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

COURSE CODE: MAT 226

COURSE TITLE: CLASSICAL MECHANICS

DATE: 12/10/18 **TIME:** 8 AM -10 AM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of **3 Printed Pages**. Please Turn Over.

QUESTION ONE (30 mks)

(a)Two particles of masses m_1 and m_2 are connected by an inextensible string of negligible mass which Passes over a fixed pulley of negligible mass. If the initial velocity is v_0 and the acceleration is given by $\frac{dv}{dt}$:

(i)show that when the system is released the motion will be described by the equation

$$v = v_0 + \left(\frac{m_2 - m_1}{m_1 + m_2}\right) gt$$ (5 mks)

(ii)Determine the tension in the string if $m_1 = 0.6kg \; and \; m_2 = 0.9kg$ (3mks)

(iii)Find the distance covered at any time $t > 0$ (2 mks)

(b) The angular momentum of a particle is given as a function of time t by $\boldsymbol{\Omega} = 3\boldsymbol{i} - (2t + 1)\boldsymbol{j} + (14t^3 - 10t^2)\boldsymbol{k}$. Find the Torque at t=1. (2 mks)

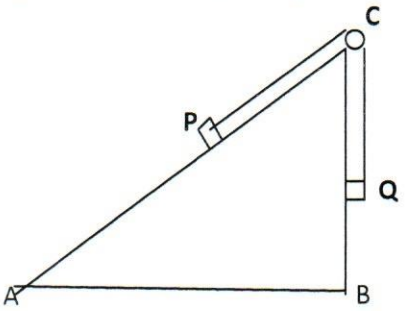
(c) A particle P of mass 4 units moves along the x-axis attracted towards the origin by a force whose magnitude is numerically equal to $10x$ and a damping force equal to 8 times the instantaneous speed. If it is initially at rest at $x = 22$. Find:

(i)the position and (9 mks)

(ii) the velocity at any time t. (3 mks)

(d) A particle starts from rest a point P and travels in a straight line with a uniform acceleration for 2.5 sec. before coming to a point Q. After another 3.5 sec. it covers a distance of 52 metres from Q, It continues with its motion for a further 4 sec. and comes to a point R. Find the distances PQ and QR. (6 mks)

QUESTION TWO. (20 mks)



The diagram shows the cross-section ABC of a smooth wedge With AB=4m, BC=3m and CA=5m. The face AB of the wedge is fixed to the horizontal ground. Two particles P and Q each of mass one kg are attached to the ends of an elastic string 8 m long. Initially P is at A. The system is released from rest.

(a) Find the acceleration of the particle and the tension in the string (7 mks)

(b) Particle Q hits the ground without rebounding. Find how far along AC measured from A proceeds before coming instantaneously to rest. (11 mks)

(c) Discuss the motion if the wedge was rough with coefficient of friction $\mu = 0.02$ (2 mks)

QUESTION THREE (20 mks)

(a) A projectile is launched with initial speed v_0 at an angle α with the horizontal . Suppose that the projectile has acting upon it a force due to air resistance equal to $-\beta v$ where β is a constant and v the instantaneous velocity.

Find :

(i) the velocity and (6 mks)

(ii) the position vector at any time. (3 mks)

(b) A particle of mass m is travelling along the x axis such that at time $t = 0$ it is located at $x = 0$ and has speed v_0. The particle is acted upon by a force which opposes the motion and has magnitude proportional to the square of the instantaneous speed.

Find :

(i) the speed (6 mks)
(ii) the position at any time t (5 mks)

QUESTION FOUR (20 mks)

(a) A particle moving with simple harmonic motion has speeds of 5 m/s and 6 m/s at distances of 10 cm and 612cm respectively from the equilibrium position. Find the period of the motion. (7 mks)

(b) A piston moves up and down, so that its height y metres is given at time t seconds by the formula $y = 0.5 \sin 4t$.
(i) Show that the motion is simple harmonic. (3 mks)
(ii) Write down the amplitude and the periodic time. (3 mks)
(iii) Find the maximum speed and the maximum acceleration. (2 mks)
(iv) At what position in the motion do they occur? (5 mks)

QUESTION FIVE (20 mks)

(a) The angular momentum of a particle is given as a function of time by $\Omega = 4t\,\boldsymbol{i} - (5t^2 + 1)\boldsymbol{j} + (14t^3 - 6t^2)\boldsymbol{k}$.
Find the torque at the time $t = 1$ (2mks)

(b) Show that the following forces are conservative:
(i) $\boldsymbol{F} = r^3\boldsymbol{r}$ and (9 mks)
(ii) $\boldsymbol{F} = (y^2 \cos x + z^3)\boldsymbol{i} + (2y \sin x - 4)\boldsymbol{j} + (3xz^2 + 2)\boldsymbol{k}$ (7 mks)

(c) At $t = 0$ a particle of unit mass is at rest at the origin. If it is acted upon by a force $F = 90te^{-2t}\boldsymbol{i}$, Find :
(i) The change in momentum of the particle in going from $t = 1$ to $t = 2$, (1 mks)
(ii) The velocity after a long time has lapsed. (1 mks)