CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACELOR OF SCIENCE IN PHYSICS

PHYS 131: MECHANICS I

STREAMS: B.Sc PHYSICS Y1S1 **TIME: 2 HOURS**

DAY/DATE: THURSDAY 7/12/2017 **2.30 P.M - 4.30 P.M.**

INSTRUCTIONS:

- **Answer Question ONE and any other TWO Questions.**
- **Do not write anything on the question paper**

QUESTION ONE (30MKS)

1) a) Given $\mathbf{r}_1=3\mathbf{i}-2\mathbf{j}+\mathbf{k}$, $\mathbf{r}_2=2\mathbf{i}-4\mathbf{j}-3\mathbf{k}$, $\mathbf{r}_3=-\mathbf{i}+2\mathbf{j}+2\mathbf{k}$. Find

i) the magnitudes of $2\mathbf{r}_1-3\mathbf{r}_2-5\mathbf{r}_3$ [2mks]

ii) $\mathbf{r}_1\times\mathbf{r}_3$ [3mks]

b) A ball is thrown vertically upwards from the ground with a velocity of 20m/s, exactly 0.5 seconds later another ball is dropped from rest from a cliff 40m above the point from which the first ball was projected. Find;

i) the time after the first ball was thrown when the two balls meet [3mks]

ii) how far above the ground they are at this time [3mks]

c) A bus of mass 2000kg moving at 10m/s on a horizontal ground is brought to rest in a distance of 12.5m by the brakes being applied. Calculate the average retarding force (F) [4mks]

d) A man of mass 60kg stands in a lift, calculate his apparent weight when the lift is

i) at rest [1mks]

ii) moving upwards with a constant velocity of 20m/s [2mks]

iii) accelerating upwards at $2m/s^2$ [2mks]

e) State Kepler's laws of planetary motion [3mks]

f) A plane flies from base camp to lake A, a distance of 280 km at a direction of 200 north of east. After dropping off suppliers, the plane flies to lake B, which is 190 km and 300 west of north from lake A. Determine the distance and direction from lake B to the base camp [5mks]

g) Show that F=ma [2mks]

QUESTION TWO (20MKS)

2 a) i) Find the angle between **A**=2**i**+2**j**-**k** and **B**=6**i**-3**j**+3**k** [5mks]

ii) Determine the value of a so that **A**=2**i** +a**j**+**k** and **B**=4**i**-2**j**-2**k** are perpendicular 5mks]

b) State any three factors affecting centripetal force [3mks]

c) A stunt pilot who has been driving vertically at 15m/s pulls out of the dive into a circle in the vertical plane.

i) what is the minimum radius of this circle, if the force on the pilot is not to exceed 0.6N [4mks]

ii) if the pilot has a mass of 80kg, what is the apparent weight of the pilot at the lowest point of the circle. [3mks]

QUESTION THREE (20MKS)

3 a) i) State the universal law of gravitation [2mks]

ii) Find the gravitational intensity at a point 1000m above mean sea level (Take R=6400km and g_o=9.81m/s^2) [4mks]

b) i) Show that gravitational potential at a point in a gravitational field is given by [4mks]

$$V = \frac{-GM}{R}$$

ii) Calculate the change in energy of a 500kg satellite when it falls from an altitude of 200km to 199km. If the change takes place during one orbit, calculate the retardation force on the satellite [4mks]

c) i) Explain the motion of a solid spherical ball dropped in a fluid [4mks]

ii) State any two factors affecting the solid friction [2mks]

QUESTION FOUR (20MKS)

4 a) i) A car initially at rest travels for two minutes with a uniform acceleration of $0.3m/s^2$, after which the speed is kept constant until the car is brought to rest with a uniform retardation of $0.6m/s^2$. If the total distance covered is 4500m, what is the time taken for the journey [7mks]

b) An object is projected at an angle θ with a velocity u, show that the range R is given as

$$R = \frac{u^2}{g} sin2\theta$$

[5mks]

c) A track travels uphill with a constant velocity on a high way with 7^0 slopes. A 50 kg package sits on the floor of the back of the truck and does not slide, due to a static friction force. During an interval in which the truck travels 340 m, what is the net work done on the package? What is the work done on the package by the force of gravity, the normal force and the friction force? [8mks]

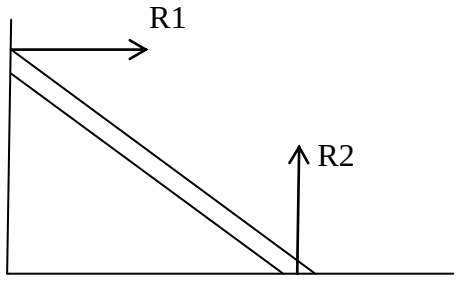
QUESTION FIVE (20MKS)

5 a) A bus of mass 2000kg travelling at 10m/s collides with a matatu which is at rest. After collision the matatu reaches a velocity of 6m/s in the initial direction of the bus, while the bus rebounds at 2m/s. If the time spend in the collision is 0.001seconds and the bus travels 0.02km after collision while the matatu travels 0.015km. Calculate,

i) the mass of the matatu [3mks]

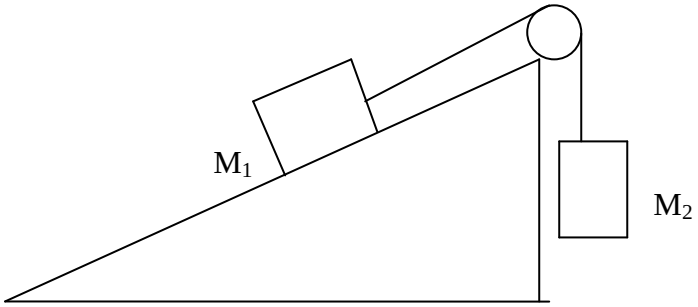
ii) the average force exerted on both the matatu and the bus during collision [3mks]

b) A uniform ladder 10m long and with a mass of 40kg rest in equilibrium against a frictionless vertical wall at an angle of 60^o to the horizontal.



Calculate the magnitude and direction of the reactions R_1 and R_2 at the two ends of the ladder [8mks]

c) Two masses M1=4 kg and M2=6 kg are attached by a massless cord passed over a frictionless pulley as shown below. Assuming there is no friction between mass M1 and the surface. Determine the acceleration of the hanging mass. [6mks]



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