KABARAK UNIVERSITY

EXAMINATIONS

2008/2009 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: **PHYS 111**

COURSE TITLE: **MECHANIC**

STREAM: **SESSION I**

DAY: **WEDNESDAY**

TIME: **2.00 – 4.00 P.M.**

DATE: **12/08/2009**

INSTRUCTIONS

1. *Use the constants; Universal Constant G = 6.67 X $10^{-11}m^3/kg.s^2$, π = 3.412 and g = 9.8N/kg*
2. *This paper contains four questions. Answer Question 1 and any other two questions.*
3. *Question 1 contains 30 marks and the rest contain 20 marks each.*

PLEASE TURN OVER

QUESTION 1 (30 MARKS)

a.) Define the term dynamics as used in mechanics. (1 mark)

b.) Give conditions that should be satisfied by a body at equilibrium. (1 mark)

c.) State the three laws of Kepler of planetary motion. (3 marks)

d.) What is the angle between vectors $\mathbf{a} = 4\mathbf{i} - 3\mathbf{j} + 2\mathbf{k}$ and $\mathbf{b} = 2\mathbf{i} - \mathbf{j} + 3\mathbf{k}$ (3 marks)

e.) Name two conservation laws. (2 marks)

f.) A pith ball of mass 0.08kg hangs from the end of a string. When wind is blowing it exerts a horizontal force on the ball which moves until the string makes an angle of 20^0 with the vertical as shown in fig 1.

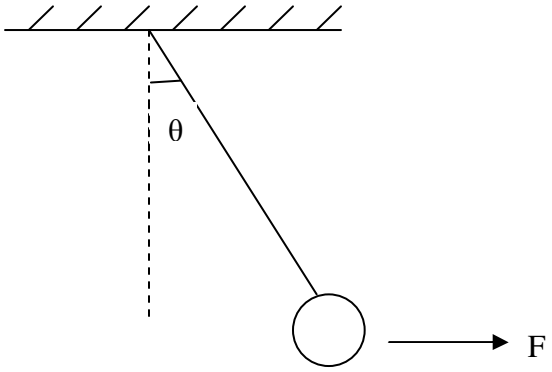

Fig 1

Find i) the force exerted by wind on the ball

ii) Tension in the string when wind is blowing (5 marks)

g.) A particle's position on the x-axis is given by $x = 4t^2 - 6t + 4$ with x in meters and t in seconds

h.) Find the particle's velocity function V(t) and acceleration function a(t) (2 marks)

ii.) At what time is V = 0? (3 marks)

i.) Sketch a graph of position versus time showing uniform acceleration.(2 marks)

j.) State Newton's second law of motion. (1 mark)

k.) A motor car of mass 1100kg starts from rest and accelerates steadily until it is traveling at 36km/h

i.) If it takes 6s to attain this speed, what is its acceleration?

ii.) Calculate the force exerted between the tires and the road to produce this acceleration.

iii.) How far does the car travel during this time? (6 marks)

l.) Define the term power> (1 mark)

QUESTION 2 (20 MARKS)

a.) An object is released from an aircraft traveling horizontally with a constant velocity of $200ms^{-1}$ at a height of 500m. Ignoring air resistance and taking g as $10ms^{-2}$ find;

i.) How long it takes the object to reach the ground. (2 marks)

ii.) Determine the horizontal distance covered by the object between leaving the aircraft and reaching the ground. (2 marks)

iii.) Determine the velocity with which it lands and the angle. (4 marks)

b.) A ball of mass 20kg is suspended by two cords as shown in fig 2 below. Determine the tension in cords A, B and C. Take g = 9.8 N/kg. (4 marks)

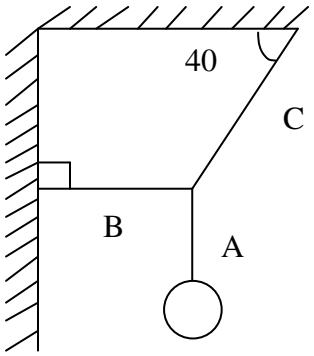

Fig 2

c.) Show that the center of mass (com) of a system of particles can be written as

$$X_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i x_i \qquad \text{(5 marks)}$$

d.) Determine the mass of the earth from the period T and the radius r of the moon's orbit about the earth (T = 27.3 days and r = 3.85 X 10^5 km). (3 marks)

QUESTION 3 (20 MARKS)

a.) A body moving along the x-axis is subject to a force repelling it from the origin, given by F = kx.

i.) Find the potential energy function U(x) for the motion and write down the conservation of energy condition. (3 marks)

ii.) Describe the motion of the system and show that this is the kind of motion we would expect near a point of unstable equilibrium. (1 mark)

b.) A 700kg car moving at 80km/h hits a stationary matatu of mass 1200kg. The two stick together and move together for 5 seconds. Calculate;

i.) the final velocity of the vehicles

ii.) Find the force of impact. (4 marks)

c.) Show that work done can be expressed as $W = p(V - V_0)$ where p is momentum and V is final velocity. (3 marks)

d.) A Matatu driver reduced the speed of his vehicle from $80kmh^{-1}$ to $50\ kmh^{-1}$ creating acceleration of $-1.2ms^{-2}$. Find

i.) the displacement (3 marks)

ii.) Time required for this change (2 marks)

e.) Show that angular momentum l can be written as $l = I\omega$ (4 marks)

QUESTION 4 (20 MARKS)

a.) A police officer fires a bullet at an angle of 38^0 from the horizontal with a speed of $300ms^{-1}$. Assume that the bullet moves in a vertical plane and that air resistance is negligible;

i.) Find the time t at which the bullet reaches the highest point of its trajectory

ii.) How high does the bullet go?

iii.) What is the range of the bullet and how long is it in air?

iv.) What is the velocity of the bullet as it strikes the ground? Take $g = 9.8ms^{-2}$ (8 marks)

b) If the magnitude of the force of attraction between a particle of mass m_1 and one mass m_2 is given by $F = \frac{km_1m_2}{x^2}$ where symbols have their usual meaning, Find the energy required to increase the separation of the masses from $x = x_1$ to $x = x_1 + d$.

c.) Two blocks are connected over a massless pulley as shown in fig 3 below. The

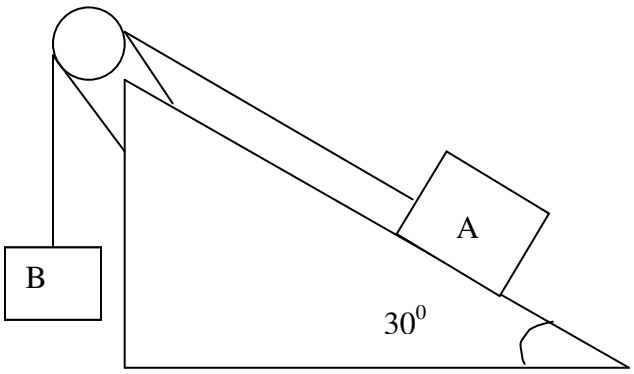

Fig 3

mass of block A is 8kg and the coefficient of kinetic friction is 0.20. Block A slides down the incline at constant speed. What is the mass of block B?