EMBU UNIVERSITY COLLEGE

(A CONSTITUENT COLLEGE OF THE UNIVERSITY OF NAIROBI)

FIRST SEMESTER EXAMINATIONS 2014/2015

FIRST YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION SCIENCE

SPH 101: MECHANICS I

DATE: DECEMBER 15, 2014   **TIME: 16:00 – 18:00**

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

Symbols have usual meaning

Constants

$g = 9.8 \text{m/s}^2$

QUESTION ONE

a) Give two examples of physical quantities with magnitude and direction but are not vector quantities. (3 marks)

b) You are provided with the following vectors:-

$P = I + j + 2k$

$Q = 2i + j + k$ and

$R = I - 2j + k$

Find

i) Magnitude of $(P - Q + R)$ (3 marks)

ii) Direction cosines of $(P + Q + R)$ (3 marks)

c) What is the difference between a perfectly elastic collision and inelastic collision?

(2 marks)

d) Explain one application of newton's third law of motion. (2 marks)

e) Explain the use of the principle of moments in the adjustment of a water tap.

(3 marks)

f) A lever AB is hinged at A and supported by a spring at C. The stiffness of the spring is 250N/cm of extension. The end of the lever carries a load of 10kg. Before the load is applied the load is horizontal. Find the downward displacement at C when the load is applied.

(3 marks)

g) A body of mass 16kg slides on a horizontal frictionless table with a speed of $0.5ms^{-1}$. It is brought to rest by compressing a spring in its path. By how much is the spring compressed, if the force constant of the spring is 0.25kg/m.

(3 marks)

h) A block of mass 6.0kg is moving along a smooth horizontal surface with a speed, u. A force of 36N is applied to the body opposite to the direction of its motion. The force reduces to half of its value while the body moves 9.0m. Calculate the time taken for this to occur. (3 marks)

i) Briefly explain how a water manometer can be used to measure pressure of a gas supply.

(3 marks)

j) A bullet of mass 7g leaves the barrel of a rifle with a velocity of $300ms^{-1}$. If the riffle recoils with a velocity of $1ms^{-1}$, find the mass of the riffle.

(2 marks)

QUESTION TWO

a) A man using a 70kg roller on a level surface exerts a force of 196N at 45^0 to the ground. Calculate the vertical force of the roller on the ground when he pulls. (3 marks)

b) Two masses m_1 and m_2 are connected by a thread over a fixed pulley block. Initially the centers of gravity of the masses are at the same height. Find the vertical direction and the

acceleration the center of gravity of the combination of masses will move if $m_1 > m_2$.

(12 marks)

c) A cube of wood of side 50cm and density 600kgm^{-3} is placed in water.

i) Find the friction of the volume of wood immersed in water. (2 marks)

ii) What force must be applied to the cube so that the top surface is on the same level as the water surface? (3 marks)

QUESTION THREE

a) A 20g bullet pierces through a plate of mass 1kg and then comes to rest inside a second plate of mass 2.98kg. It is found that the two plates initially at rest, now move with equal velocities. Find the percentage loss in the initial velocity of the bullet when it is between the two plates kept apart, neglect any loss of material of the plates, due to action of the bullet. (11 marks)

b) A fly wheel rotating at 200 revolutions per minute slows down at a constant rate of 2rads^{-2}. Find the time required to stop the fly wheel and how many revolutions does it make in the process. (9 marks)

QUESTION FOUR

a) A particle of mass, m, is being acted upon by a force, F, which makes the particle to move with a velocity, V, in a time interval, t. show that the angular momentum of the particle is conserved.

(9 marks)

b) A rigid body of mass, M, is rotating with a uniform angular velocity, ω, about an axis, AA', passing through its center. Assuming that the body is made of small particles, where one particle is at, P, at a distance, r, from the axis of rotation. Show that the total energy of the body is:-

$$E = \frac{1}{2}MV^2 \left(1 + \frac{K^2}{r^2}\right)$$

(11 marks)

QUESTION FIVE

a) Using a venturi tube discuss the use of Bernoulli's principle in measurement of fluid pressure.

(10 marks)

b) A rocket travelling in a horizontal straight line at 10kms⁻¹, explodes and breaks up into two parts of mass 1tonne and 0.2tonnes respectively. Both parts travel in same direction as before but measurements show that the light section is moving 1000ms⁻¹ faster than the heavier part. Calculate the velocity of each section.

(10 marks)

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