MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF EDUCATION (SCIENCE)

SPH 200: MECHANICS II

DATE: 19/12/2017 **TIME: 8.30-10.30 AM**

INSTRUCTIONS:

Answer question one and any other two questions

QUESTION ONE (30 MARKS)

a) Distinguish between conservative and non-conservative forces. Give an example of each. (2 marks)

b) State the two properties of conservative forces. (2 marks)

c) A 77 kg diver drops from a board 10 m above the water surface. Use conservation of mechanical energy to find his speed 5 m above the water surface. (3 marks)

d) A jet lands on an aircraft carrier at a speed of 63m/s.

(i) What is its acceleration (assumed constant) if it stops in 2.0 s due to an arresting cable that snags the jet and brings it to a stop? (2 marks)

(ii) If the jet touches down at position $x_i = 0$, determine its final position? (2 marks)

e) If a man weighs 900N on the Earth, what would he weigh on Jupiter, where the free-fall acceleration is 25.9m/s^2? (3 marks)

f) An automobile travels due west on a level road for 3 km. It then turns due north at an intersection and travels 4 km before stopping. Determine the resultant displacement of the car. (3 marks)

g) State the law of conservation of linear momentum. (2 marks)

h) Find the torque produced by a 300 N force applied at an angle of 60^0 and at 2m from the hinges of the door. (2 marks)

i) Define moment of inertia of a body. Write its mathematical expression. (2 marks)

j) A mass-spring system undergoes simple harmonic motion with an amplitude A.

i. Does the total energy change if the mass is doubled but the amplitude is not changed? (2 marks)

ii. Explain if the kinetic and potential energies at a given point in its motion are affected by the change in mass. (2 marks)

k) Define the terms; Young's modulus, shear modulus and bulk modulus. (3 marks)

QUESTION TWO (20 MARKS)

a) Define simple harmonic motion. (1 mark)

b) The motion of an object is described by the equation; $x = (0.3\,\text{m})\cos\left[\left(\frac{\pi}{3} Hz\right) * t\right]$. Find;

i. The position of the object at t = 0 and t = 0.6 s (2 marks)

ii. The amplitude of the motion (2 marks)

iii. The frequency of the motion, and (1 mark)

iv. The period of the motion. (1 mark)

c) A simple 2-m long pendulum oscillates in a location where g = 9.8 m/s^2. How many complete oscillations does it make in 5 min? (3 marks)

d) A uniform string, shown in Figure 1, has a mass of 0.3 kg and length of 6 m. Tension is maintained in the spring by suspending a 2 kg block from one end. Determine the speed of a pulse on this string. (5 marks)

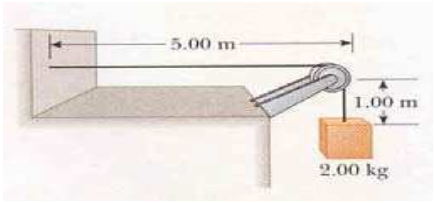

Figure 1

e) State the principle of conservation of momentum. (1 mark)

f) Passengers on a carnival ride move at constant speed in a horizontal circle of radius 5.0 m, making a complete circle in 4.0 s. Determine their acceleration? (4 marks)

QUESTION THREE (20 MARKS)

a) Distinguish between a scalar and a vector quantity giving an example of each. (2 marks)

b) Given the two displacements; $\vec{D} = (6.0\hat{i} + 3.0\hat{j} - 1.0\hat{k})$ m; and $\vec{E} = (4.0\hat{i} - 5.0\hat{j} + 8.0\hat{k})$ m,

(i) Find the magnitude of the displacement $2\vec{D} - \vec{E}$. (2 marks)

(ii) Find the angle between the two vectors. (2 marks)

c) Define the center of mass of a body. Write down the mathematical expressions for the components. (2 marks)

d) Three thin rods, each of length L are arranged in an inverted U. the two rods on the arms of the U each have mass m; the third rod has mass 3 m. where is the center of mass of the assembly? (3 marks)

e) Define linear momentum and write down its components in a 2-D motion. (2 marks)

f) A penguin stands at the left edge of a uniform sled of length L, which lies on frictionless ice. The sled and penguin have equal masses.

i. Where is the center of mass of the sled? (1 mark)

ii. How far and in what direction is the center of the sled from the center of mass of the sled-penguin system? (1 mark)

iii. The penguin then waddles to the right edge of the sled, and the sled slides on the ice. Does the center of mass of the sled-penguin system move leftward, rightward, or not at all? (1 mark)

g) Distinguish between an elastic collision and inelastic collision. (2 marks)

h) Two blocks as shown in figure below slide without friction. (i) What is the velocity of the 1.6 kg block after the collision? (ii) is the collision elastic? (3 marks)

QUESTION FOUR (20 MARKS)

a) State the principle of conservation of momentum. (1 mark)

b) Passengers on a carnival ride move at constant speed in a horizontal circle of radius 5.0 m, making a complete circle in 4.0 s. What is their acceleration? (4 marks)

c) Work men are trying to free a car stuck in the mud. To extricate the vehicle, they use three horizontal ropes, producing the force vectors shown in Figure 3 below.

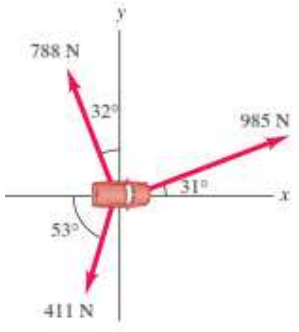

Figure 3

(i) Find the x- and y-components of each of the three pulls. (4 marks)

(ii) Use the components to find the magnitude and direction of the resultant force of the three pulls. (4 marks)

d) A small ball of mass m is suspended from a string of length L. The ball revolves with constant speed v in a horizontal circle of radius r as shown in Figure 4 below.

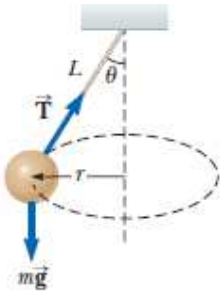

Figure 4

e) Find an expression for v in terms of the geometry in the figure. (7 marks)

QUESTION FIVE (20 MARKS)

a) Write down the mathematical relationships between angular and linear quantities.(3 marks)

b) A machine part rotates at an angular velocity of **0.6 rad/s**; its value is then increased to **2.2 rad/s** at an angular acceleration of **0.7 rad/s^2**. Find the angle through which the part rotates before reaching the final velocity. (2 marks)

c) State the Newton's Universal law of Gravitation. (2 marks)

d) A robotic lander with an earth weight of 3430 N is sent to Mars which has radius $R_m=3.40\ X\ 10^6\ m$ and mass $m_M=6.42\ X\ 10^{23}\ kg$. Find the weight F_g of the lander on the Martian surface and the acceleration there due to gravity, g_M. (5 marks)

e) A bowling ball of mass 7 kg and a radius of 12 cm rotates about the z-axis in a counterclockwise direction with an angular momentum $\vec{L}$ in the positive z-direction.

Determine the magnitude of the angular momentum of the bowling ball spinning at 10 rev/s. (4 marks)

f) A traffic light weighing 122 N hangs from a cable tied to two other cables fastened to a support as in Figure 5 below. The upper cables make angles of $\theta_1 = 37.0^0$ and $\theta_2 = 53.0^0$ with the horizontal.

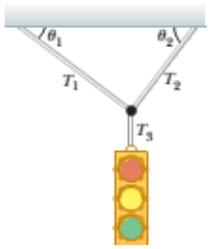

Figure 5

These upper cables are not as strong as the vertical cable and will break if the tension in them exceeds 100 N. Does the traffic light remain hanging in this situation, or will one of the cables break? (4 marks)