



MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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UNIVERSITY EXAMINATIONS 2023/2024

FIRST YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN PHYSICS AND BACHELOR OF EDUCATION SCIENCE

SPH 3100: MECHANICS I

DATE: DECEMBER 2023

TIME: 2 HOURS

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

- a) Using unit analysis show that the equation $h = gt^2$ is correct. Where h is the height reached by a stone thrown upwards vertically, g is acceleration due to gravity and t is time.
(3 Marks)
- b) In an experiment to measure the acceleration due to gravity a student measured height of a cliff from which a stone was dropped and the time taken to hit the ground measured. Given that the height was $h = 100 \mp 0.05m$ and the average time was $\Delta t = 4.5 \mp 0.01s$. find the fractional error in acceleration due to gravity.
(4 Marks)
- c) The position of a moving particle from a particle from a point O is represented by the vector $r = 2i - 3j + k$. If the particle moves a displacement (s) represented by the vector $S = -2i + j - 3k$. Find the position vector representing the new position of particle from the point O.
(3 Marks)
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ISO/IEC 27001:2013 CERTIFIED

- d) Define the cross product of two vectors. (1 Mark)
- e) A university driver drove from Windhoek to Ongwediva campus for at an average speed of 80 km/h. if a third of the distance was driven at 96km/h, calculate the distance between these two campuses and the average speed for the remaining part of the journey. (5 Marks)
- f) A jetliner land and begins to slow to a stop as it moves along the runway. If its mass is $1.4 \times 10^5 \text{ kg}$, its speed is 27.0 m/s, and the net braking force $4.2 \times 10^5 \text{ N}$, what is its speed 7.50 s later? (3 Marks)
- g) A 3.00 kg particle has a velocity of $(3.0i - 4.0j) \text{ m/s}$. Find its x and y components of momentum and the magnitude of its total momentum. (5 Marks)
- h) A bus of mass 6300 kg is moving with a uniform acceleration of 0.2 m/s^2 . Find the work done by the engine in driving the bus in 3 minutes. (3 Marks)
- i) A body moving in a circular path of radius 0.7 m describes an arc length of 1.4 m. find the angular displacement of the particle in degrees. (3 Marks)

QUESTION TWO (20 MARKS)

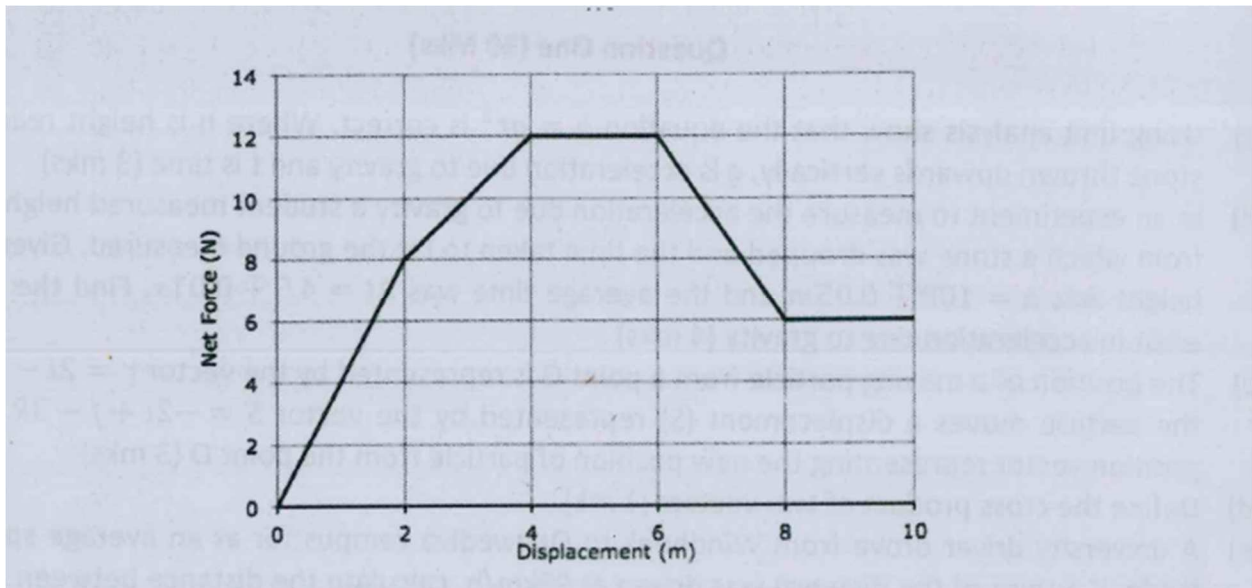
- a) A missile was launched from Jerusalem at a velocity of 1200 m/s to hit a target in Gaza at height of 2400 m above the position of launch. If the angle of projection was 36° from the horizontal find:
- Maximum height reached by the missile. (3 Marks)
 - Time taken by the missile hit the target. (3 Marks)
 - The distance of the target from the point of launch. (4 Marks)
- b) A train accelerates uniformly from rest at a station A to a maximum speed of 72km/h. The constant maximum speed is maintained for a period of time and the train then decelerates uniformly until it comes to a stop at station B. The distance between the two railway stations is 22km and the journey takes 20 minutes. If the magnitude of the acceleration is half that of deceleration, by using graphical method, determine:
- The acceleration, in metre per second. (7 Marks)



- ii. The time during which the train travels at its maximum speed (3 Marks)

QUESTION THREE (20 MARKS)

- a) A 50.0N force is applied horizontally to a 12.0kg block which is initially at rest. After traveling 6.45 m, the speed of the block is 5.90 m/s. What is the coefficient of kinetic friction (6 Marks)
- b) A 6.00 kg mass is acted on by a net force shown in the graph below. _____
- Find the work done by the force in each section of the movement (8 Marks)
 - If the object started from rest, what is its velocity after it has moved 10.0 m? (3 Marks)
 - If the object in initially was moving at 5.00 m/s in the direction of the net force, what was its speed after it had moved a distance of 6.00 m? (3 Marks)



QUESTION FOUR (20 MARKS)

- a) A car of mass 1200 kg drives around a curve with a radius of 25.0 m. If the driver maintains a speed of 20.0 km/hr,
- what is the force of friction between the tires and the road? (5 Marks)
 - What is the minimum coefficient of static friction required to keep the car in this turn? (5 Marks)
- b) The moon's mass is 7.35×10^{22} kg, and it moves around the earth approximately in a circle of radius 3.82×10^5 km. The time required for one revolution is 27.3 days. Calculate the centripetal force that must act on the moon (5 Marks)
- c) Two vectors are represented in coordinate system by the position vectors $\vec{a}(2, -1, 4)$; $\vec{b}(-3, 2, 4)$. Find the cross product of the two vectors (5 Marks)

