



NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES

DEPARTMENT OF PHYSICS

2024 1 EXAMINATION

COURSE CODE: PHY 301
COURSE TITLE: CLASSICAL MECHANICS
CREDIT UNIT: 3
TIME ALLOWED: (3 HRS)

INSTRUCTION: *Answer question 1 and any other three questions*

QUESTION 1

- a. Define generalized force, Conservative force, Potential Energy
12marks
- b. Prove that in the same central force as in question A, the speed of a particle at any point in a parabolic orbit is $\sqrt{2}$ times the speed in a circular orbit passing through the same point.
13Marks

QUESTION 2

- a. Define virtual displacement **3marks**
- b. In the following cases, discuss whether the constraint is holonomic or non-holonomic. Specify the constraint force.
- i. Motion of a body on an inclined plane under gravity. **(3 Marks)**
- ii. A bead on a circular wire. **(3 Marks)**
- iii. A particle moving on an ellipsoid under the influence of gravity. **(3 Marks)**
- iv. A pendulum with variable length. **(3 Marks)**

QUESTION 3

- a. Briefly explain the term Constraint **3Marks**
- b. Vector A extends from the origin to a point having polar coordinates $(7, 70^\circ)$ and vector B extends from the origin to a point having polar coordinates $(4, 130^\circ)$. Find $A \cdot B$. **4Marks**
- c. An observer at rest with respect to the ground observes a particle of mass $m_1 = 3\text{kg}$ moving along the x-axis with a velocity $u_1 = 3\text{m/s}$. It approaches a second particle of mass $m_2 = 1\text{kg}$ moving with velocity $u_2 = -3\text{m/s}$ along the same axis. After head-on collision, he finds that the velocity of m_2 is $u_2' = -3\text{m/s}$ along the x-axis. What are the momenta before and after the collision as seen by a moving observer walking with a velocity of 2m/s relative to the ground along the x-axis?
(8 marks)

QUESTION 4

- a. Define Work done

3marks

A projectile of mass M explodes in flight into three pieces. The first mass $m_1 = M/2$ continues to travel in the same direction as the original projectile. The second mass $m_2 = M/6$ travels in the opposite direction and $m_3 = M/3$ comes to rest. The energy E converted from chemical energy of the explosive to final state mechanical energy is five times the initial kinetic energy of the projectile. What are the velocities of the three pieces?

12Marks

QUESTION 5

- a. Discuss the Lagrangian Approach to Mechanics

3Marks

- b. Calculate the work done by gravity on a particle shot upward with velocity $\vec{v} = v_0 \vec{z}$ in the time 0 to t_f .

12Marks

QUESTION 6

- a. Define the two types of constraints

6Marks

- b. What work is done by a force $F = (2xN)\hat{i} + (3N)\hat{j}$, with x in meters, that moves a particle from a position $r = (2m)\hat{i} + (3)\hat{j}$ to a position $r_f = -(4m)\hat{i} - (3)\hat{j}$

9marks

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