# MAASAI MARA UNIVERSITY

## REGULAR UNIVERSITY EXAMINATIONS
## 2022/2023 ACADEMIC YEAR
## *MASTERS YEAR* ONE *FIRST* SEMESTER

## SCHOOL OF PURE, APPLIED AND HEALTHY SCIENCES
## MASTERS OF SCIENCE(PHYSICS)

## COURSE CODE: PHY8103

## COURSE TITLE: CLASSICAL MECHANICS

**DATE: APRIL, 2023** **TIME: 2HOURS**

**INSTRUCTIONS TO CANDIDATES**

1. Answer Question **ONE** and any other **Two** questions

*This paper consists of XXXXXXXXX printed pages. Please turn over.*

## Question one [30 Marks]

a) Distinguish between holonomic and non-holonomic constraints giving two examples in each case. [6marks]

b) State two difficulties introduced by constraints in the solution of mechanical problems [4marks]

c) Using the D'Alembert's principle show that the Lagrange's equations is given by [6marks]

$$\frac{d}{dt}\left(\partial\frac{\partial L}{\partial \overset{*}{q}_j}\right)-\frac{\partial L}{\partial q_j}=0$$

d) State the Hamilton's principle [2marks]

e) Determine the shortest distance between two points in a plane. [6marks]

f) A particle of mass m moves in one dimension such that it has the Lagrangian

$$L=\frac{m^2\dot{x}^4}{12}+m\dot{x}^2V(x)-V^2(x)$$

Where V is some differentiable function of x. Find the equation of motion for x(t) and describe the physical nature of the system on the basis of this equation. [6marks]

## QUESTION TWO (20MARKS)

a) A particle moves in the x-y plane under the constraint that its velocity vector is always directed towards a point on the x-axis whose abscissa is some given function of time f(t). Show that for f(t) differentiable, but otherwise arbitrary, the constraint is non-holonomic. [6marks]

b) Obtain the Lagrangian equations of motion for a spherical pendulum, i.e a mass point suspended by a rigid weightless rod. [5marks]

c) If L is a Lagrangian for a system of n degrees of freedom satisfying Lagrange's equations, show by direct substitution that

$$L^{'}=L+\frac{dF(q_1,\ldots..,q_n,t)}{dt}$$

Also satisfies Lagrange's equations, where F is any arbitrary, but differentiable, function of its arguments. [9marks]

## QUESTION THREE (20MARKS)

a) State and Explain the three Kepler's law's [3marks]

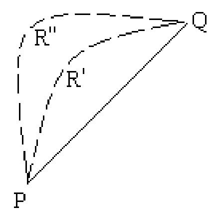
a) Determine the shortest distance between two points in a plane. [6marks]

b) Use Hamilton's Principle to find the equation of motion of a one-dimensional harmonic oscillator. [7marks]

c) For a gas undergoing a reversible process $dU = TdS - PdV$ using enthalpy H(S,P) which is generated from the Legendre transformation $H = U + PV$ find the new expression for T and V. [4marks]

**QUESTION FOUR [20 Marks]**

a) For the conservative holonomic system shown in the figure below state two conditions that must be satisfied For the deduction of Hamilton's Principle [4marks]




a) Derive the Lagrange equation from the Hamilton's Principle [10marks]

b) Define the central force and state it properties [6marks]