## M.Sc. (Physics) First Semester Old

0134 - Classical Mechanics Paper-II

1. Either
a) Explain D'Alembert principle.
b) Starting from D' Alemberts principle derive langrage's equation for conservative system.
c) Find the equation of motion for simple pendulum by using Lagrange's equation.

## OR

e) i) What are constraints? Discuss briefly the classification of constraints.

1) Rigid body
2) Simple pendulum
f) Deduce Hamilton's Principle from D' Alembert's principle?
2. Either
a) i) Define generalized momentum and cyclic coordinates.
ii) Show that the generalized momentum corresponding to a cyclic coordinate remain constant.
iii) Prove the law of conservation of momentum for a system of particles.
b) i) What is Hamiltonian function? Explain its physical significance. Prove that Hamiltonian of a conservative system is equal to the total energy of the system.
ii) Describe the Hamiltonian equations for an ideal spring mass arrangement.

## OR

e) i) Prove that poison braket of two dynamical variables is invariant under infinitesimal canonical transformation.
ii) And show that the transformation defined by
$\mathrm{q}=\sqrt{2 \mathrm{P}} \sin \mathrm{Q}$ $\mathrm{p}=\sqrt{2 \mathrm{p}} \cos \mathrm{Q}$ is canonical.
f) Use Hamilton - Jacobi's theory to solve Kepler's problem.
3. Either
a) i) Show that in an elliptical orbit of a planet around the sun, the major axis solely depends on the total energy.
ii) Further prove that the periodic time is an elliptical orbit is
$T=2 \pi \mathrm{a}^{3 / 2} / \sqrt{\mathrm{G}(\mathrm{M}+\mathrm{m})}$
Where $a$ is the semi major axis and $M$ the mass of the sun and $m$ that of the planet.
b) Use Hamilton's equation to find the differential equation for planetary motion and prove that the areal velocity is constant.

## OR

e) Define scattering cross-section and find the expression of Rutherford's scattering crosssection.
f) Show that for any repulsive central force a formal solution for the angle of scattering can
be expressed as
$\phi=\pi+\int_{0}^{u_{0}} \frac{\mathrm{pdu}}{\sqrt{1-\frac{\mathrm{V}}{\mathrm{E}}-\mathrm{p}^{2} \mathrm{u}^{2}}}$
Where V is the potential every $\mathrm{u}=1 / \mathrm{r}$ and $\mathrm{u}_{0}$ corresponds to the turning point of the orbit.
4. Either
a) Define Angular momentum of a rigid body and find its expression in terms of moments of Inertia and product of Inertia.
b) Show that the kinetic energy of a rotating rigid body in a coordinate system of principal axes is given by

$$
\mathrm{T}=\mathrm{y}_{2}\left(\mathrm{I}_{1} \mathrm{~W}_{1}^{2}+\mathrm{I}_{2} \mathrm{~W}_{2}^{2}+\mathrm{I}_{3} \mathrm{~W}_{3}^{2}\right)
$$

## OR

e) What are Euler's Angles? Find the matrix of transformation and its inverse matrix.
f) Consider a rectangular cube of density $\rho$ and mass $M$ and side a for origin $O$ at one corner and axes along of the edges of the cube, determine the inertial tensor.
5. Answer all the following.
a) What type of difficulties arise due to the constraints in the solution of mechanical problems and how these are removed.
b) Prove that Poisson bracket of two constant of motion is itself a constant of motion.
c) Explain and prove total energy of a particle under the action of central force is constant.
d) Using conditions of principal moments of Inertia define spherical top, symmetric top. and asymmetric top.

