**Name :** **Roll No**

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# University of Hyderabad
# School of Physics

**M.Sc.-I/IMSc.-IV** Classical Mechanics **July 2, 2018**
**May 14-Jul 6 (2018)** **MM: 12**

## Final Examination-PART-A

**Instructions**

1. Answers for Part-A to be written on this sheet itself.
2. The answers for PART-B are to be written in a separate answer book.
3. Maximum Time for Part-A is 30 mins.
4. Attempt ALL questions from Part-A.

[1] Complete the following table [4]

| Symmetry | Conservation Quantity |
|---|---|
| Translations | |
| Rotation about axis along (1,1,1) | |
| | $y$ component of angular momentum, $L_y$ |
| | Center of mass moves with constant velocity |

[2] Define generalized coordinates. [2]

[3] Define canonical transformation in two different ways. [4]

[4] Plot effective potential for a particle in three dimensional potential $\lambda r^4$. [2]

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## Final Examination-PART-B

**Attempt any FOUR questions**

[1] (a) A particle in two dimensions moves in a potential $V(r) = -\alpha/r^2$, write the Lagrangian and the Hamiltonian of the system in plane polar coordinates. [6]

(b) Give cyclic coordinates and constants of motion. How will you use constants of motion solve the problem fully. Obtain full answers except that You need not do any integrals. [6]

[2] (a) Given type 1 generator of a canonical transformation to be [6]

$$F_1(q, Q) = \frac{1}{2} m\omega q^2 \cot Q$$

find expression for the type 2 generator $F_2(q, P)$ for this transformation.

(b) Express $Q, P$ as functions of $q, p$. [6]

[3] Consider the motion in a spherically symmetric potential

$$V(r) = -V_0 \left( \frac{3R}{r} + \frac{R^3}{r^3} \right)$$

If orbital angular momentum of the particle is given by $l^2 = 10mV_0R^2$, and answer the following questions.

($a$) Plot the effective potential as a function of $r$ [3]

($b$) What should be the energy of the particle so that it may move in a circular orbit? How many circular orbits are possible? Find the radius of the stable orbit. [3+3+3]

[4] Set up Lagrangian for a triatomic linear molecule. Assuming atoms move only along line joining them and that all the three atom have equal masses and the two bonds are of equal strengths Verify that one of the frequencies of small oscillations is zero. Find the remaining frequencies of small oscillations.(See Fig Below.) [4+4+4]

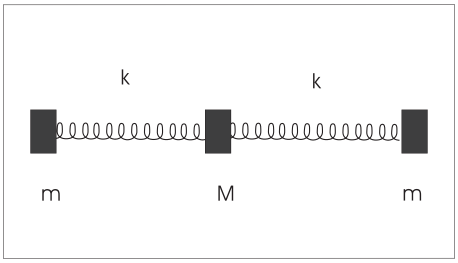


Fig. **1** for Q.4

[5] (i) Define Poisson bracket. [3]

(ii) Compute the following Poisson brackets. [3+3+3]

$(a)\ \{L_x, \vec{a}\cdot\vec{p}\}_{\text{PB}}$ $(b)\ \{\vec{a}\cdot\vec{r}, \vec{b}\cdot\vec{p}\}_{\text{PB}}$ $(c)\ \{L_z, r^n\}_{\text{PB}}$

Here $\vec{a} = (a_1, a_2, a_3), \vec{b} = (b_1, b_2, b_3)$ are numerical vectors.

[6] A pendulum is attached to a mass $M$ which moves freely on a horizontal plane. You may assume that the pendulum oscillates in a vertical plane. See Fig.2 Selecting the generalized coordinates as indicated,

$(a)$ Set up the Lagrangian

$(b)$ Obtain the equations of motion

$(c)$ Find the cyclic coordinates and conserved quantities.[4+4+4]

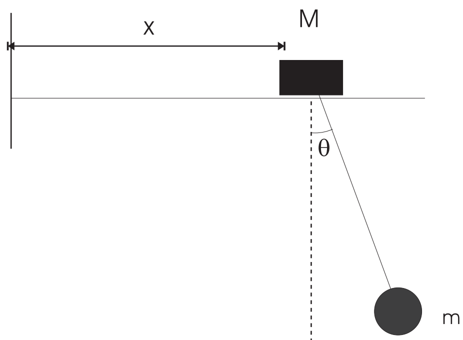


Fig. **2** for Q.6