Indian Institute of Technology Guwahati

Tutorial-2 PH4030: Classical Mechanics Dated 20 August 2026

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1. A block of mass m slides on a frictionless inclined plane which is driven so that it moves horizontally. The displacement of the plane at time t is some function x(t). Use d'Alembert's principle to find the equation of motion of the block taking the displacement s of the block down the plane as the generalized coordinate.

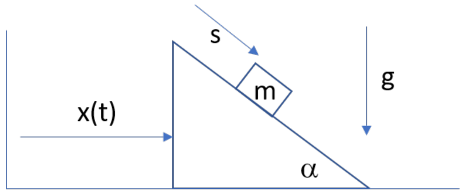

Figure 1:

2. A mass m is attached to a light cord which wraps around a frictionless pulley of mass M, radius R, and moment of inertial I. Gravity g acts vertically downwards. Use d'Alembert's principle to find the acceleration of m.

3. Masses m and 2m are connected by a light inextensible string which passes over a pulley of mass 2m and radius a. Write the Lagrangian and find the acceleration of the system.

4. The point of support of a simple pendulum of mass M and length L is moving along horizontal axis with a constant velocity V. Write down the Lagrange equation.

5. A simple pendulum that is free to swing the entire solid angle is called a spherical pendulum. Find the differential equation of motion of a spherical pendulum using Lagrange's method. Also show that the angular momentum about a vertical axis through the point of support is a constant of motion.

6. Consider a bead of mass m sliding without friction on a wire bent in the shape of a parabola, which is spun with a constant angular velocity ω about its vertical axis. Use cylindrical polar coordinates and let the equation of the parabola be $z = k\rho^2$. Write down the Lagrangian in terms of ρ as the generalised coordinate. Find the equation of motion of the bead and determine whether there are positions of equilibrium (i.e. there are value of ρ at which the bead can remain fixed without sliding up or down the spinning wire).

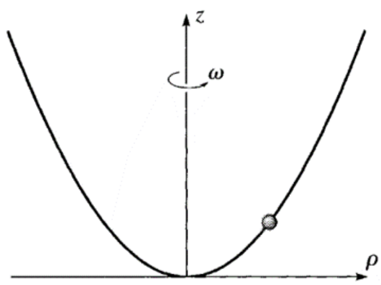

Figure 2:
