

واجب ( 5 درجات )

Question 1:

A sphere of radius  $\rho$  is constrained to roll without slipping on the lower half of the inner surface of a hollow cylinder of inside radius  $R$ . Determine the Lagrangian function, the equation of constraint, and Lagrange's equations of motion. Find the frequency of small oscillations.

Question 2:

A particle of mass  $m$  is attracted to a force center with the force of magnitude  $k/r^2$ . Use plane polar coordinates and find Hamilton's equations of motion.

Question 3:

If a particle is projected vertically upward to a height  $h$  above a point on Earth's surface at a northern latitude  $\lambda$ , show that it strikes the ground at a point  $\frac{4}{3} \omega \cos \lambda \cdot \sqrt{8h^3/g}$  to the west. (Neglect air resistance, and consider only small vertical heights.)