A mass m is constrained to move on a parabola $z = a\,x^2$ in a vertical plane under the influence of a uniform gravitational field. Attached to it is a simple pendulum of length l and mass m.

1. Choose a suitable set of generalized coordinates and obtain the Lagrangian.
2. Expand the Lagrangian around the equilibrium position by retaining up to quadratic terms in the small displacements.
3. Determine the frequencies of small oscillations.