

**[mex36] Noether's theorem II: rotation in space**

Consider the Lagrangian  $L = \frac{1}{2}m(\dot{x}^2 + \dot{y}^2 + \dot{z}^2) - V(x^2 + y^2, z)$  of a particle with mass  $m$  moving in 3D space under the influence of a scalar potential.

Identify an infinitesimal symmetry transformation. Then apply Noether's theorem to determine the associated constant of the motion. Perform the calculation using (a) Cartesian coordinates  $x, y, z$ , (b) cylindrical coordinates  $r, \phi, z$ .

**Solution:**