

Physics 440, Autumn 2019 Activity 18: Canonical transformation (free particle)

The Hamiltonian for a free particle in three dimensions is

$$H = \frac{1}{2m}(p_x^2 + p_y^2 + p_z^2)$$

- a. Find the canonical transformation that take you from Cartesian coordinates to cylindrical coordinates, and find the new Hamiltonian. Start from the transformation equations $x = r \cos \phi$, $y = r \sin \phi$, $z = Z$. Use a generating function of the type $F_3(Q, p, t)$.
- b. Find the canonical transformation that take you from Cartesian coordinates to spherical coordinates, and find the new Hamiltonian. Start from the transformation equations $x = r \sin \theta \cos \phi$, $y = r \sin \theta \sin \phi$, $z = r \cos \theta$. Use a generating function of the type $F_3(Q, p, t)$.