

3. A particle of charge Q and mass m is constrained to move along a circle of radius R , which lies in the $z = 0$ plane, centered at $(x, y, z) = (0, 0, 0)$. Passing through this circle is an ideal infinitely long straight cylindrical solenoid of radius $R_0 < R$, which is centered on the z axis. Assume that the magnetic field vanishes outside of the solenoid, and is constant, $\vec{B} = B\hat{z}$, inside the solenoid.
- (a) Write down a Hamiltonian for this particle, in terms of the angular position θ of the particle on the circle, and the given parameters B , Q , m , R and R_0 .
- (b) Find the complete spectrum of this particle's eigenenergies, as a function of the given parameters.