Question 3

For a one dimensional Harmonic Oscillator, the Hamiltonian can be expressed as:

$$H(x,p) = \frac{1}{2}kx^2 + \frac{p^2}{2m}$$

The Hamilotinian Equations are:

$$\frac{dx}{dt} = \frac{\partial H}{\partial p} \qquad (1)$$

$$\frac{dp}{dt} = -\frac{\partial H}{\partial x} \qquad (2)$$

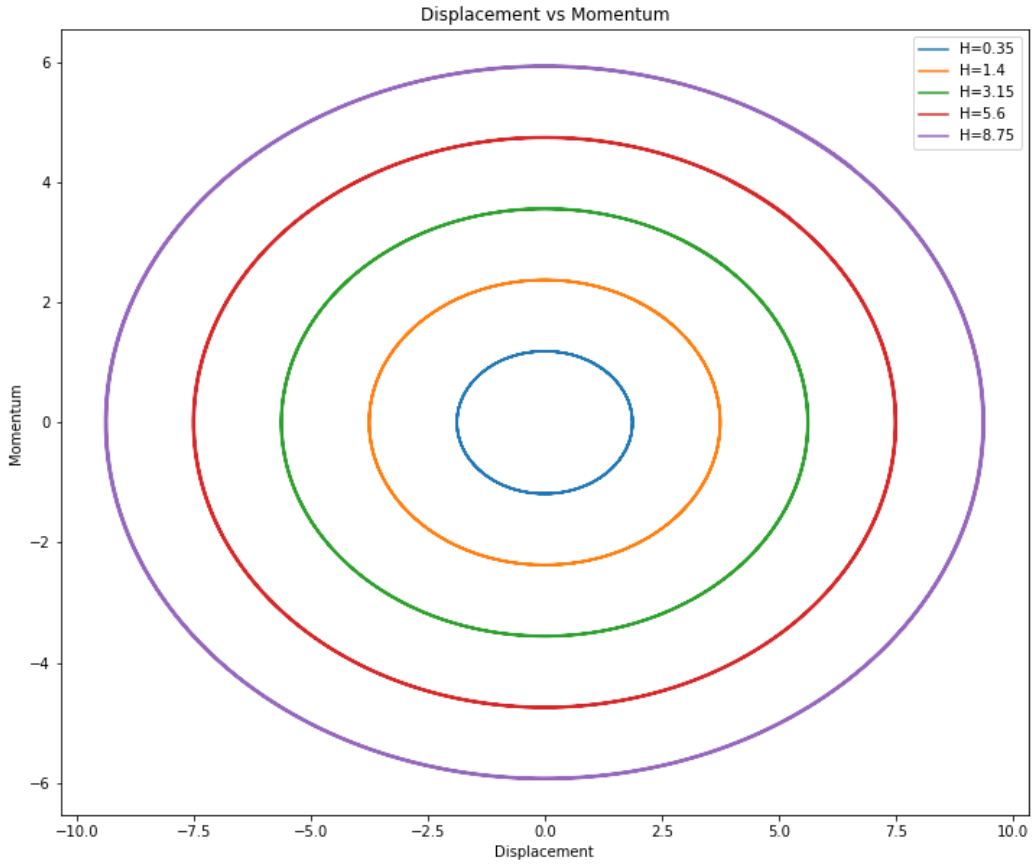
From (1),

$$\frac{dx}{dt} = \frac{\partial H}{\partial p} = \frac{p}{m}$$

From (2),

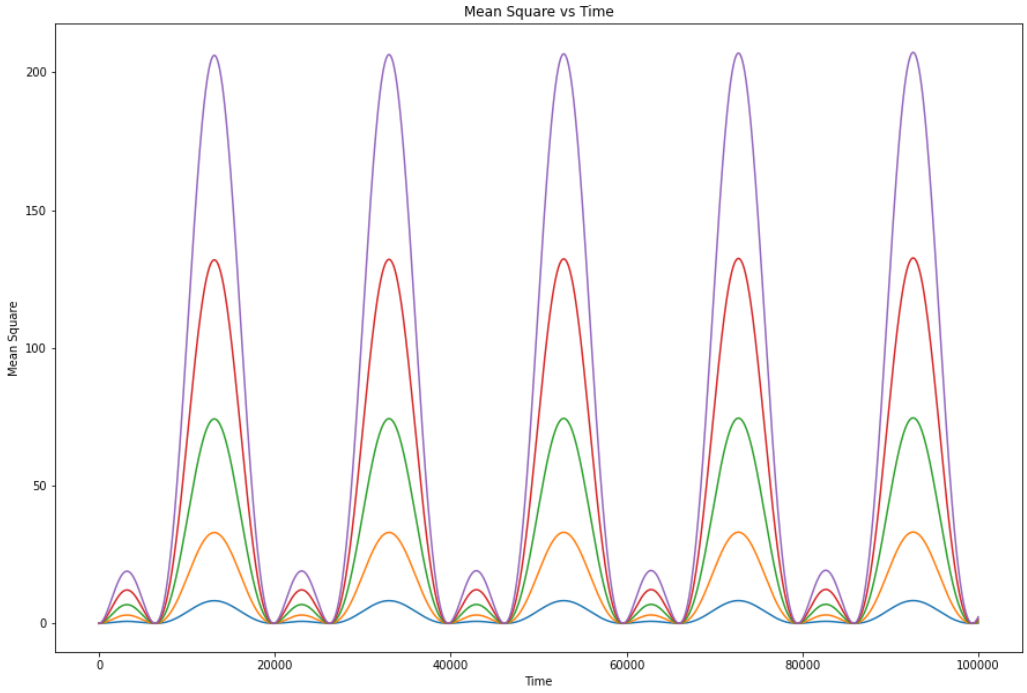
$$\frac{dp}{dt} = -\frac{\partial H}{\partial x} = -kx$$

Displacement vs Momentum Graph:



The Hamiltonian remains constant through out every elliptical contour line.

Mean Squared Deviation vs Time:



The mean squared deviation oscillates as expected.