Quantum Mechanics
PHL555

Problem Set 1

Classical mechanics and Basic probability

Find the configuration space, the momentum space and the phase space associated with the following systems

1. A particle moving on a straight line along the x-axis
2. A particle constrained to move in the region $0 < x < \infty$
3. Two particles constrained to move inside and on a sphere of radius R
4. A rigid body free to move all over the space
5. A rigid body with whose centre of mass is a t a fixed distance from the origin
6. A pendulum with its end point fixed
7. A pendulum with its support free to move on a horizontal surface

Basic ideas of probability theory

1. The mass of an object is measured a number of times (in g)and the results are given as below:

Attempt #	Value	Attempt #	value
1	0.50	2	0.54
3	0.55	4	0.55
5	0.57	6	0.54
7	0.53	8	0.50
9	0.54	10	0.55

Determine the mean mass and the standard deviation in the mass. How would you present the results of your measurements?

2. Consider an infinite one dimensional lattice of spacing a. The probability of finding an electron at the n^{th} lattice is given by $P(n) = \frac{1}{|n|!}$.

   Normalize the probability.

   Determine the mean position of the electron.

   Determine the rms distance of the electron from the origin.

3. Let the phase space space distribution for a classical particle be given by $f(x,p) = \exp(-x^2/X^2)\exp(-p/P); P > 0$. Determine Δx and Δp.

4. The probability density for a two particle system (in one spatial dimension) is given by $f(x_1, x_2) = \frac{1}{|x_1 - x_2|}$. What are the probability densities for each of the particles? Can you normalize the density?

5. You are given a Lorentzian distribution for the mass of a resonance in an experiment: $P(m) = \frac{C}{m^2+M^2}$ where M is a fixed quantity. Normalize the distribution and determine C. Neatly plot the probability density, and determine the standard deviation in m.