Problem sheet : 3

PHY 202; Relativity and quantum physics.
IISER, Pune. (April, 2009)

This is not meant for evaluation and need not be submitted back. However, you are welcome to approach me for any doubts and clarifications.

1. A particle is in infinite potential well of width L. The energy states are given by, $E = n^2h^2/8mL^2$. Find the number of accessible energy states in the energy range $[E, E + dE]$.

2. Consider harmonic oscillator with energy $E = (n + 1/2)h\nu$ (ν is the frequency). Show that the number of accessible states in the range of energy $[E, E + dE]$ is a constant independent of energy E.

3. Find the classical turning points for a particle with energy $E = mv^2/2 + bx$.

4. According to Maxwell-Boltzmann distribution, the probability of the system being in a state with energyy E is given by $Ae^{-E/kT}$. Determine the normalisation constant A.

5. Show that the most probable speed of an ideal-gas molecule is $\sqrt{2kT/m}$.

6. At what temperature would one in a thousand of the atoms in a gas of atomic hydrogen be in the $n = 2$ energy level.

7. Starting from the energy distribution of ideal-gas particles, calculate the average energy of the system.

8. Consider a system of two quantum particles (Fermions in this case) in two states. If we denote the state of the entire system by $\Psi_{n,m}(x_1, x_2)$, where n and m indicate quantum numbers and x_1, x_2 are position of particles, construct an explicitly anti-symmetric form for this state. Show that the probability of two particles being in the same state is zero.

9. A system of particles has two accessible states with energies E_1 and E_2. If there are N particles in the system in equilibrium at temperature T, find the number of particles with energy E_1.

10. At what temperature will the average molecular kinetic energy in hydrogen gas be equal to the binding energy of the hydrogen atom.

11. Consider 3 bosons in a system with 3 possible energy states. Enumerate all the possible energy configuration of the system.

12. Calculate the rms speed of ideal gas molecules starting from the distribution of molecular speeds.