

Physics 410 - 2002

# Thermal Physics

## Problem Set 3

1. Consider a particle of mass  $m$  confined in a one-dimensional potential box with walls at  $x = 0$  and  $x = L$ . (a) Plot the classical trajectory of the particle in phase space  $(p, x)$ ; (b) Find the phase volume  $\Gamma_0(E)$  for all energies  $\leq E$ ; (c) Find the total number of quantum states with energies  $\leq E$  assuming that  $E \gg \hbar^2/2mL^2$ . Compare the result with  $\Gamma_0(E)/2\pi\hbar$  (6 pt)
2. Answer the questions (b) and (c) of the previous problem for a 3-dimensional particle in a cubic potential box of size  $L$ . (9 pt)
3.  $N$  molecules of an ideal gas are placed in a container of volume  $V$ . Let a part of these molecules,  $n$ , occupy volume  $v$ . The system is in thermal equilibrium. (a) Find the probability distribution  $P(n)$  and show that it is Gaussian for large  $N, n$ ; (b) Find  $\langle n \rangle$  and  $\langle (n - \langle n \rangle)^2 \rangle$  in this case (8 pt)

You need to have 20 points out of 23 (3 points are extra credit).