Quiz 4

Answer the questions in the spaces provided. If you run out of room for an answer, continue on the back of the page.

Question:	1	2	3	Total
Points:	20	5	0	25
Score:				

Name and section: _____

1. Consider a system divided into two subsystems A and B each with three particles ($N_A = N_B = 3$) in either of two energy states $\varepsilon = 1$ or $\varepsilon = 0$. The initial state of this system is shown in fig. 1. Assume the system starts with all three particles in A in the $\varepsilon = 1$ state, and then the subsystems are put into thermal contact where energy is allowed to move between A and B, but the total energy $U = U_A + U_B$ remains constant.

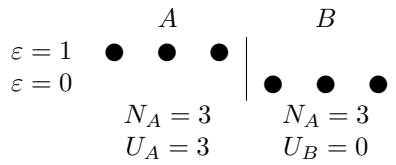

Figure 1: Initial condition for system considered in question 1

(a) (10 points) What are the multiplicities W of the possible energy distributions of this whole system (accounting for both subsystems)?

$U_A = 0,\ W = 1$

$U_A = 1,\ W = 9$

$U_A = 2,\ W = 9$

$U_A = 3,\ W = 1$

(b) (10 points) What are the relative probabilities of each possible configuration?

$U_A = 0,\ p = \frac{1}{20}$

$U_A = 1,\ p = \frac{9}{20}$

$U_A = 2,\ p = \frac{9}{20}$

$U_A = 3,\ p = \frac{1}{20}$

2. (5 points) Now consider a different system with two different subsystems C and D where $N_C = 12$ and $N_D = 6$. If the total energy $U = 6$, and the two subsystems are in thermal contact, what are the expected energies in each of the two subsystems?

$N_C = 12,\ N_D = 6$ $\quad$ $N_C = 12,\ N_D = 4$ $\quad$ $N_C = 15,\ N_D = 5$

$\langle U_C \rangle = 4$ $\quad$ $\langle U_C \rangle = 3$ $\quad$ $\langle U_C \rangle = \frac{15}{4}$

$\langle U_D \rangle = 2$ $\quad$ $\langle U_D \rangle = 1$ $\quad$ $\langle U_D \rangle = \frac{5}{4}$

3. For fun if you finish early: What is the matrix formulation for the second order term in the Taylor series expansion of $P(V,T)$ around the point (V^*,T^*) that we started discussing yesterday? Assume $n=1$.

$$P(V,T) = \frac{RT}{V}$$

We will discuss this next week, but it might be good to think about first.