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.

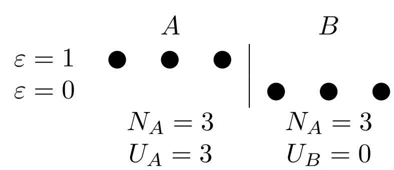


Figure 1: Initial condition for system considered in question 1

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

$U_A = 0$, $W =$

$U_A = 1$, $W =$

$U_A = 2$, $W =$

$U_A = 3$, $W =$

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

$U_A = 0$, $p =$

$U_A = 1$, $p =$

$U_A = 2$, $p =$

$U_A = 3$, $p =$

2. (5 points) Now consider a different system with two different subsystems $C$ and $D$ where $N_C = 12$ and $N_D = 4$. If the total energy $U = 4$, and the two subsystems are in thermal contact, what are the expected energies in each of the two subsystems?

$\langle U_C \rangle =$

$\langle U_D \rangle =$

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.