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Phy 232
Claves Einstein

hw for 11/15/17

T2M.5, T3B.3

T2M.5
Does relative size matter?
a) Use StatMech to generate tables for the following 5 different Einstein solid pairs:

	U_A, U_B at peak	$\frac{U_A}{N_A}$, $\frac{U_B}{N_B}$
(1) $N_A = N_B = 50$ →	50ϵ, 50ϵ	1ϵ/osc, 1ϵ/osc.
(2) $N_A = 60$, $N_B = 40$	60.3ϵ, 39.7ϵ	1.005ϵ/osc. 0.9925ϵ/osc.
(3) $N_A = 70$, $N_B = 30$	70.6ϵ, 29.4ϵ	$1.00\overline{857142}\epsilon$/osc, 0.98ϵ/osc
(4) $N_A = 80$, $N_B = 20$	80.9ϵ, 19.1ϵ	1.01125ϵ/osc, 0.955ϵ/osc
(5) $N_A = 90$, $N_B = 10$	91.2ϵ, 8.8ϵ	$1.01\overline{3}\epsilon$/osc, 0.88ϵ/osc

In each case, choose $U = 100\epsilon$. Compute average energy per oscillator [compare $\frac{U_A}{N_A}$ to $\frac{U_B}{N_B}$] for the value of U_A corresponding to the peak probability as reported by StatMech below the graph.

The average energy per oscillator of A seems to increase while the average energy per oscillator of B seems to decrease

b) State a simple approximate rule describing how U_A/N_A compares to U_B/N_B in the most probable macropartition. Is your rule always exactly true?
This is approximately true $\frac{U_A}{N_A} \approx \frac{U_B}{N_B}$
This is only Exactly true when $N_A = N_B$

c) How does your rule fare when you increase all numbers (N_A, N_B, U) simultaneously by a factor of 100? Does its accuracy improve for the more extreme cases?
The approximation becomes much more accurate when N_A, N_B are large

d) How will your rule fare in the limit that $N_A + N_B$ becomes extremely large?
I think that as $N_A + N_B \to$ Big, the approximation will become, for all practical applications, exact. This is because for large N, most of the energy is stored in only a few macropartitions out of lots of macropartitions, due to be present of virtually all the microstates in these few macropartitions

T3B.3

Two [illegible] Einstein solids in a certain macropartition have multiplicities of $4.2 \cdot 10^{320}$ and $8.6 \cdot 10^{132}$.

a) What are the entropies of each solid

$S = k_b \ln(\Omega) = $ "

Let solid A be the solid with multiplicity $\Omega = 4.2 \cdot 10^{320}$

Let solid B be the solid with multiplicity $\Omega = 8.6 \cdot 10^{132}$

So $S_A = k_b \cdot \ln(4.2 \cdot 10^{320}) = k_b(\ln 4.2 + 320 \cdot \ln(10)) = k_b(1.43 + 320 \cdot 2.3) = \boxed{738 k_b}$

$S_B = k_b \cdot \ln(8.6 \cdot 10^{132}) = k_b \cdot [\ln 8.6 + 132 \cdot \ln(10)] = k_b \cdot (2.15 + 132 \cdot 2.3) = \boxed{306 \cdot k_b}$

b) $S_{tot} = S_A + S_B = \boxed{1044 k_b}$

Full answers:

T2M.5: Reasonable

T3B.3: Reasonable magnitude, right units