TABLE IIIA-5: A 6 PARTICLE SYSTEM OF BOLTZONS

	MACROSTATE					w_i	p_i	R_i	$\overline{\varepsilon_i^{1/2}}/B_o^{1/2}$	$\frac{\lvert\hat{\varepsilon}_i^{1/2} - \overline{\varepsilon^{1/2}}\rvert}{\varepsilon^{1/2}}$ %
i	$n_{1,i}$	$n_{2,i}$	$n_{3,i}$	$n_{4,i}$	$n_{5,i}$					
I	0	2	1	3	0	43,740	0.505	5.05	2.975	0.333
II	1	0	2	3	0	14,580	0.168	1.68	2.946	0.605
III	1	1	0	3	1	9,720	0.112	1.12	2.932	1.088
IV	0	1	4	0	1	7,290	0.084	0.84	2.985	0.697
V	0	2	2	0	2	7,290	0.084	0.84	2.971	0.212
VI	1	0	3	0	2	1,620	0.018	0.18	2.943	0.727
VII	1	1	1	0	3	1,080	0.012	0.12	2.928	0.726
VIII	0	0	6	0	0	729	0.008	0.08	3.000	1.212
IX	0	3	0	0	3	540	0.006	0.06	2.956	0.273
X	2	0	0	0	4	15	0.0001	0.001	2.886	2.631
						86,604	1.000	Avg. 1.00	$\hat{\varepsilon}^{1/2}/B_o^{1/2} = 2.964$	Avg. 0.850

find that p_{mp} is reduced from that of the 4 particle system. Yet observe that the pseudo-pressure deviation is also reduced ($N = 4$, $p_{mp} = 0.537$, $|\hat{\varepsilon}^{\frac{1}{2}} - \overline{\varepsilon_{mp}^{\frac{1}{2}}}|/\hat{\varepsilon}^{\frac{1}{2}} = 0.442$; $N = 6$, $p_{mp} - 0.505$, $|\hat{\varepsilon}^{\frac{1}{2}} - \overline{\varepsilon_{mp}^{\frac{1}{2}}}|/\hat{\varepsilon}^{\frac{1}{2}} = 0.333$). An understanding of why this somewhat paradoxical trend occurs can be achieved by defining *relative macrostate probability*, R_i. In terms of the smaller, 4 particle system with its 5 macrostates, if macrostates were equally probable then each would have a probability of 1 in 5 or 0.20. But macrostates are not equally probable. Thus, the most probable macrostate appears (0.537/0.20 =) 2.68 times its "fair share." Or more formally,

$$R_i \equiv p_i I^* \qquad \text{(IIIA-12)}$$

Macrostates with relative probability above one exceed "fair share" probability; those below one are relatively unlikely. Macrostates with large relative probability are disproportionately likely. In the 6 particle example the first three macrostates have relative probabilities above one. The most probable macrostate exceeds its fair share by almost twice the factor of the 4 particle example ($R_{mp,6} = 5.05$; $R_{mp,4} = 2.68$). Therefore, even though the absolute probabilities are lower in the larger system, the distribution is more distorted in favor of its high probability macrostates.

Ans. 12. There are three macrostates, $I^* = 3$. Their distributions and pseudo-pressures are shown at right.

i	$n_{1,i}$	$n_{2,i}$	$n_{3,i}$	$\overline{\varepsilon_i^{1/2}}/C$	w_i^A	p_i^A	w_i^B	p_i^B	w_i^C	p_i^C
I	2	0	2	1.3660	6	0.300	0	0	54	0.2524
II	1	2	1	1.3901	9	0.450	1	1.0	144	0.6729
III	0	4	0	1.4142	5	0.250	0	0	16	0.0747
					20		1		214	

II. (a) He^4 is composed of 2 neutrons, 2 protons, and 2 electrons; thus these 4 indistinguishable particles are Bosons. (b) Indistinguishable molecules composed of normal and heavy hydrogen atoms have an odd number of substomic components and are Fermions. (c) the correct answer is Boltzons, since each of the 4 particles is distinguishable from the others.

III. The number of microstates and their probabilities are shown in the table. In addition the pseudo-pressure deviations are: (A) 1.3889, 0.0876%; (B) 1.3901, 0.0%; (C) 1.3858, 0.310%.