Clicker/Poll Question

Which of the following best describes the number of microstates and the number of macrostates for a system of five distinguishable spin-1/2 particles? (Also: What quantity distinguishes each macrostate?)

A. 32 microstates, 5 macrostates
B. 32 microstates, 6 macrostates
C. 25 microstates, 5 macrostates
D. 25 microstates, 6 macrostates
E. None of the above

Clicker/Poll Question

Suppose you have an Einstein solid consisting of 3 oscillators and 2 units of energy. How many microstates are there?

A. 3 microstates
B. 6 microstates
C. 8 microstates
D. 9 microstates
E. None of the above

Clicker/Poll Question

Which of these configurations has the highest multiplicity (A or B)?

$$\Omega(N, q) = \binom{q + N - 1}{q} = \frac{(q + N - 1)!}{q!\,(N - 1)!}.$$

A. 100 oscillators with 3 total units of energy
B. 3 oscillators with 100 total units of energy
C. The two situations have the same multiplicity

Clicker/Poll Question

What is the probability that the system is in its most likely microstate?

$q_{total} = q_A + q_B = 100$

$N_A = 300$ and $N_B = 200$.

A. Around 7%
B. Around 31%
C. Around 69%
D. Around 93%
E. Very close to 100%

q_A	Ω_A	q_B	Ω_B	Ω_{total}
0	1	100	2.8×10^{81}	2.8×10^{81}
1	300	99	9.3×10^{80}	2.8×10^{83}
2	45150	98	3.1×10^{80}	1.4×10^{85}
3	4545100	97	1.0×10^{80}	4.6×10^{86}
4	3.4×10^{8}	96	3.3×10^{79}	1.1×10^{88}
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
59	2.2×10^{68}	41	3.1×10^{46}	6.8×10^{114}
60	1.3×10^{69}	40	5.3×10^{45}	6.9×10^{114}
61	7.7×10^{69}	39	8.8×10^{44}	6.8×10^{114}
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
100	1.7×10^{96}	0	1	1.7×10^{96}
				9.3×10^{115}

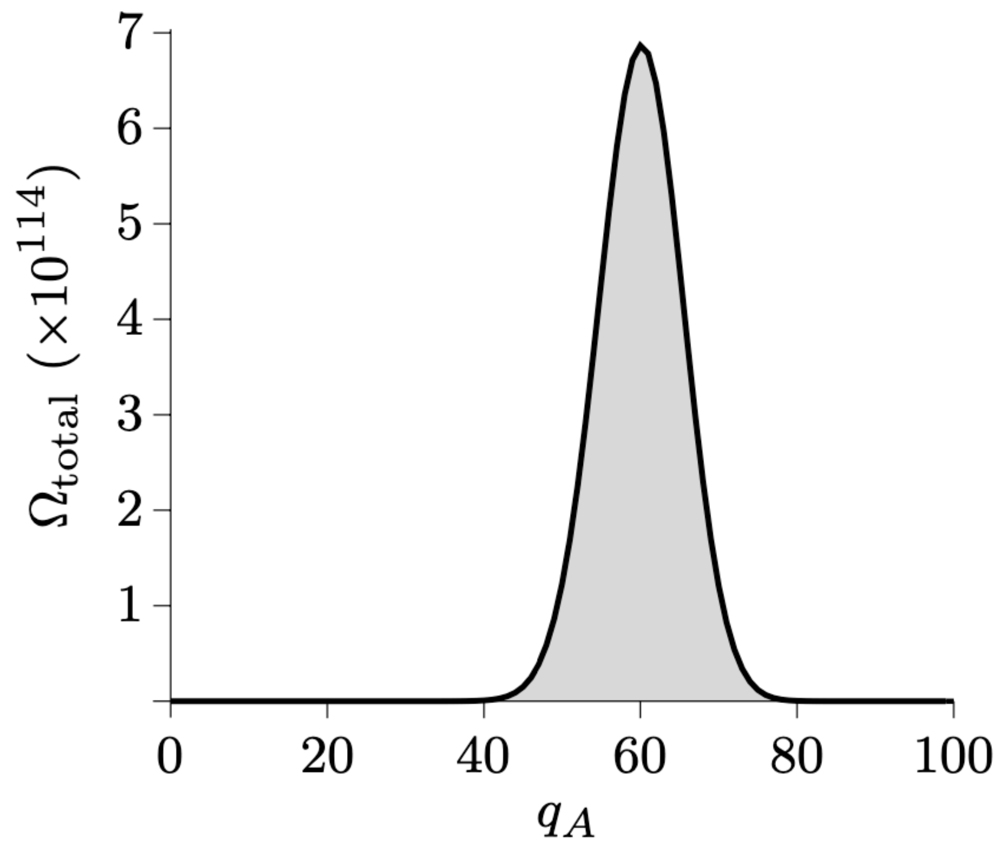


Figure 2.5. Macrostates and multiplicities of a system of two Einstein solids, with 300 and 200 oscillators respectively, sharing a total of 100 units of energy.

Clicker/Poll Question

Which of the following two approximations (1 & 2) is/are acceptable?

1. $10^{23} + 10^{23} = 10^{23}$
2. $10^{2\times 10^{23}} \times 10^{23} = 10^{2\times 10^{23}}$

A. 1 is okay, but 2 is not

B. 2 is okay, but 1 is not

C. Both approximations are acceptable

D. Neither approximation is acceptable

Clicker/Poll Question

Stirling's approximation says that $100 \cdot 99 \cdot 98 \cdot (\cdots) \cdot 2 \cdot 1$ is approximately x^{100}, where x is…

A. 100
B. $100/e$
C. $100 \ln 100$
D. $100 \ln 100 - 100$

Clicker/Poll Question

Which of the following is closest to $(400!)$?

A useful fact is that $e^6 \approx 400$. *Hint: Use Stirling's Approximation for* $\ln 400!$

A. e^{1000}

B. e^{1600}

C. e^{1800}

D. e^{2000}

E. e^{2400}

Clicker/Poll Question

Suppose a random number generator is simulating coin-flips. You would like to test whether it is truly random or not, by making sure that there are not too many heads or tails after enough flips. After having it flip 2,000,000 times, the number of heads that comes up is a little more than one million: 1,015,000. Is this a standard statistical error, or is it likely there is something wrong with the random number generator?

A. This is well within the standard fluctuations that you'd expect.
B. This is a little unlikely, but possible even if the random number generator is fine (about a 1% chance). Try it again?
C. The chance of this result is less than one in a million, and there is likely something wrong with the random number generator.

Clicker/Poll Question

Suppose an instructor designs a test so that 50% of the class will get 100% and 50% of the class will get 0%. The CLT says that, in the limit of an infinite number of students, what distribution will be Gaussian?

A. The number of students vs. exam score
B. The probability of outcome vs. average exam score
C. The number of students vs. average exam score

Clicker/Poll Question

If the volume of an ideal gas doubles (and the energy and number of particles remains constant), what happens to the entropy?

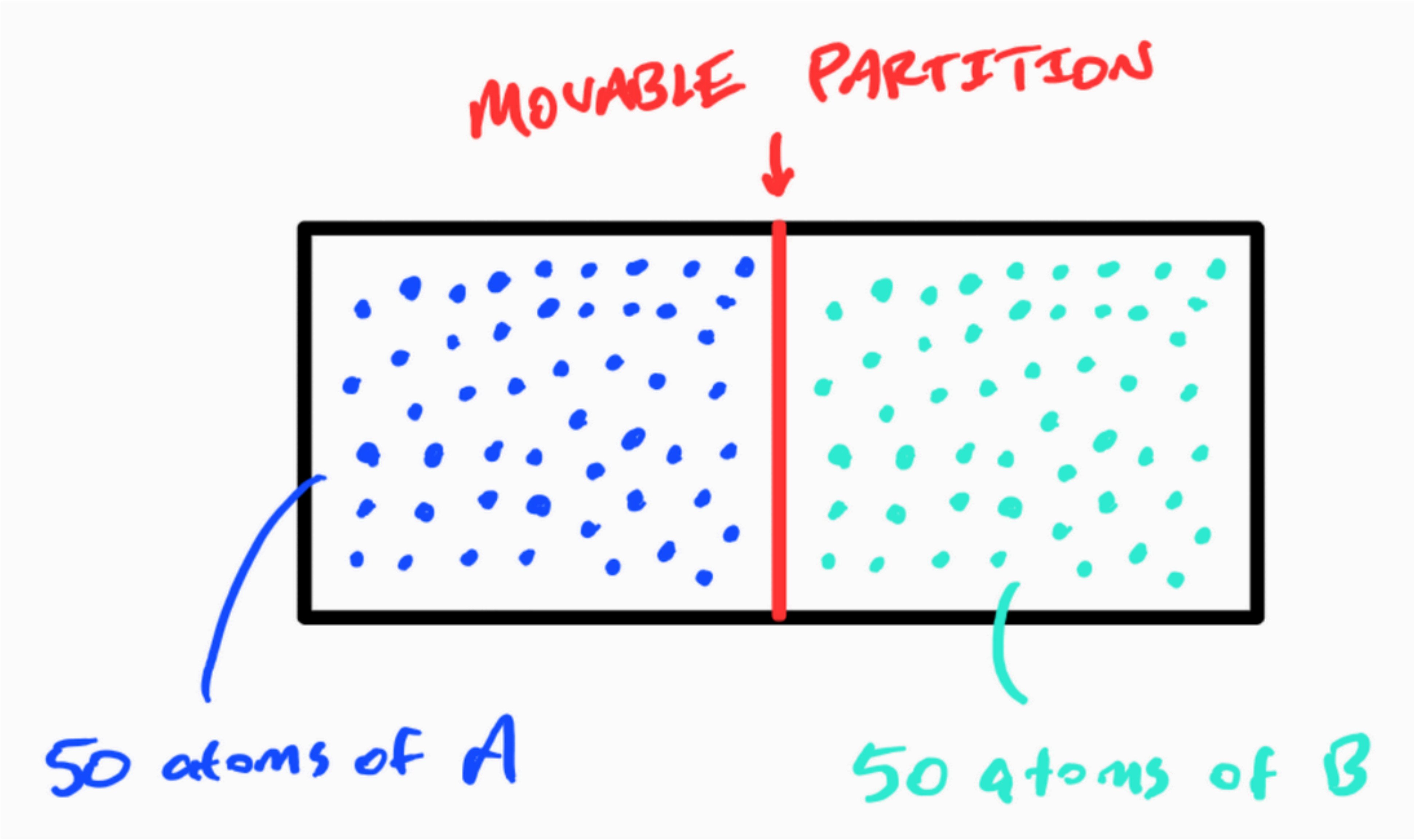
$$S = Nk\left[\ln\left(\frac{V}{N}\left(\frac{4\pi mU}{3Nh^2}\right)^{3/2}\right) + \frac{5}{2}\right].$$

A. The entropy increases to $\ln 2$ times its original value.
B. The entropy increases to 2 times its original value.
C. The entropy increases by an amount $2Nk$.
D. The entropy increases by an amount $Nk\ln 2$.
E. The entropy remains the same under these conditions.

Clicker/Poll Question

Particle types A & B are identical except for a newly-discovered property called “freshness.”

If the partition is removed, does the entropy increase?



A. Yes, the entropy definitely increases.
B. No, the entropy definitely remains the same.
C. The answer depends on our ability to measure “freshness.”