Theme Music: Jerry Lee Lewis

Whole Lotta Shakin’ Goin’ On

Cartoon: Wiley Miller
Non Sequitur
### Quiz 2

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<th>1.1</th>
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<th>2.1</th>
<th>2.2A</th>
<th>2.2B</th>
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**Average = 7.3**
The Equation of the Day

Combinatoric counting

\[ C_{N,M} = \frac{N!}{(N - M)!M!} \]
Suppose I have a block of matter with 4 two-state “Degrees of Freedom” (bins in which to place energy that can only hold 1 energy packet).

I have 2 packets of thermal energy. How many ways are there to distribute 2 packets? (i.e., How many microstates are there?)
Suppose an isolated box of volume $2V$ is divided into two equal compartments. An ideal gas occupies half of the container and the other half is empty. When the partition separating the two halves of the box is removed and the system reaches equilibrium again, how does the entropy of the gas compare to the entropy of the original system?

1. The entropy increases
2. The entropy decreases
3. The entropy stays the same
4. There is not enough information to determine the answer
Doubling the size of the box

Consider each side of the box as being broken into $M$ small volumes. We can put a molecule into one of these volumes in $M$ different ways.

So to put $N$ particles into the box we can put them in $M \times M \times M \ldots \times M$ (N times) different ways. $W_1 = M^N$.

If we have 2 boxes we can put them each into the bigger box in $2M$ different ways.

So to put $N$ particles into the double box, $W_2 = (2M)^N = 2^N M^N = 2^N W_1$

What does this say about the change in entropy when the size of the box is doubled?
Foothold ideas: Exponents and logarithms

- **Power law:** 
  \[ f(x) = x^2 \quad g(x) = Ax^7 \]
  a variable raised to a fixed power.

- **Exponential:** 
  \[ f(x) = e^x \quad g(N) = 2^N \quad h(z) = 10^z \]
  a fixed constant raised to a variable power.

- **Logarithm:** the inverse of the exponential.
  \[ x = e^{\ln(x)} \quad x = \ln(e^x) \]
  \[ y = 10^{\log(y)} \quad y = \log(10^y) \]

- \[ \log(2) = 0.3010 \quad \log(e) = 0.4343 \]
- \[ 2^N = (10^{0.3010})^N \approx 10^{0.3N} \]
- \[ e^x = (10^{0.4343})^x \approx 10^{0.4x} \]
- \[ 2^N = B \]
- \[ N \log 2 = \log B \Rightarrow N = \frac{\log B}{\log 2} \]