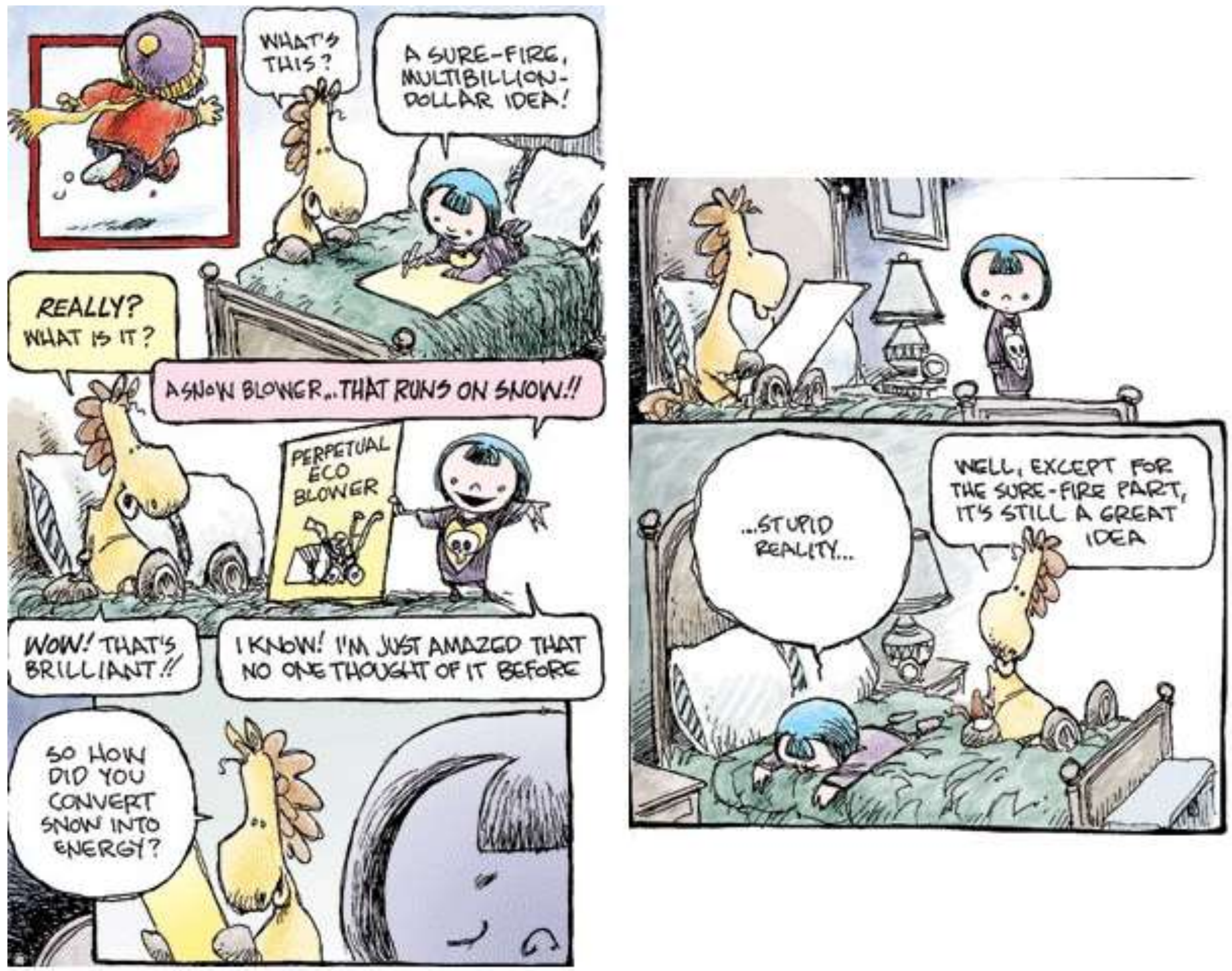
February 10, 2016 Physics 132 Prof. E. F. Redish

- **Theme Music:** **Jerry Lee Lewis**

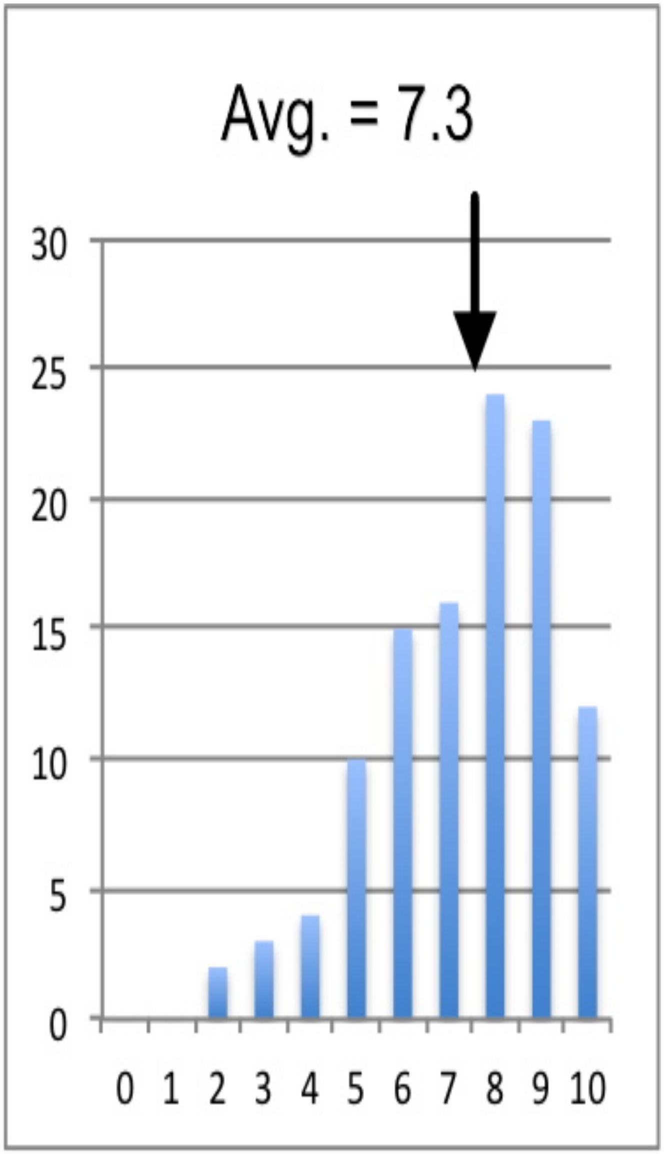
***Whole Lotta Shakin' Goin' On***

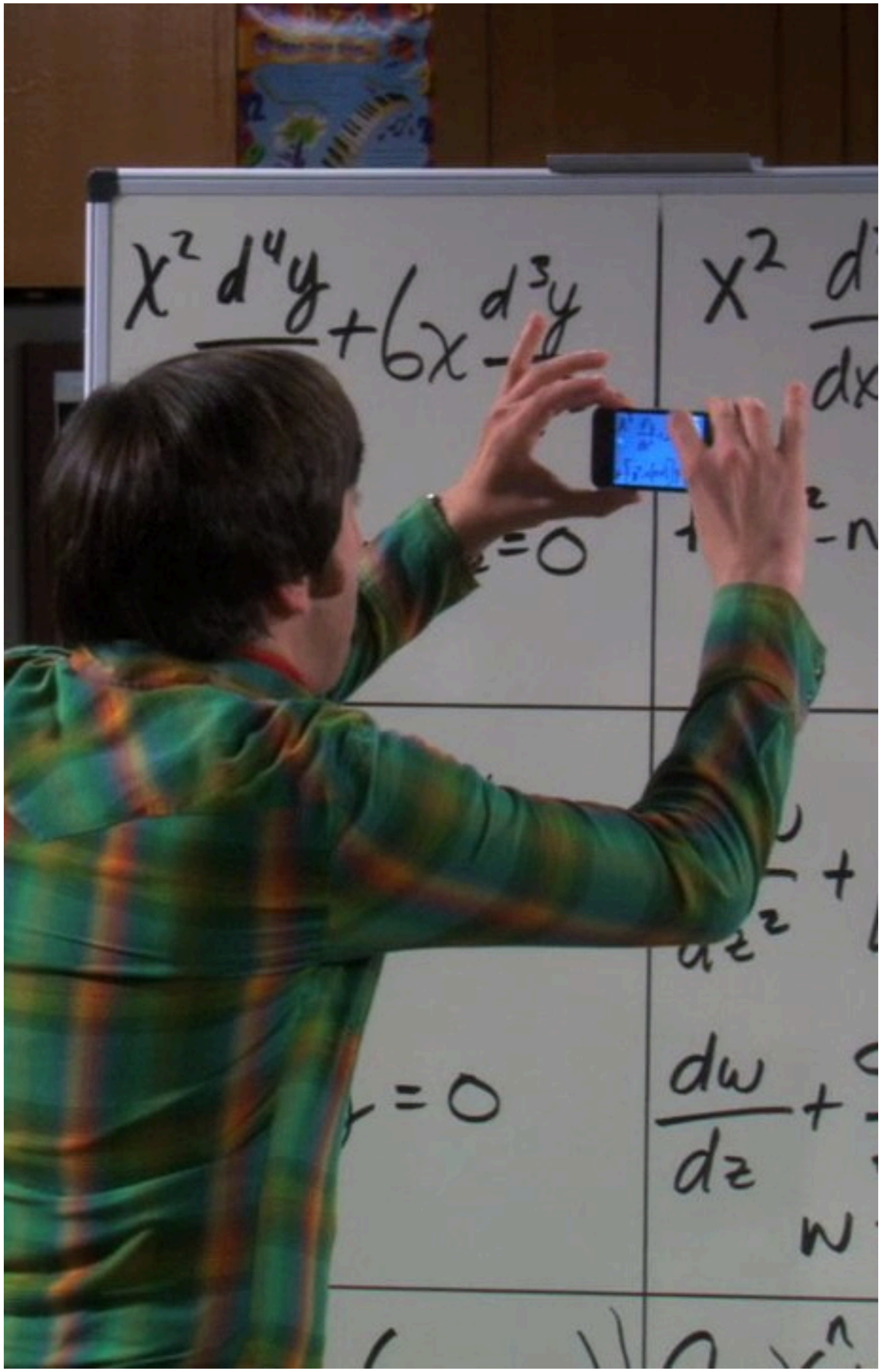
- **Cartoon:**
  **Wiley Miller**
  ***Non Sequitur***



# Quiz 2

| | 1.1 | 1.2 | 2.1 | | 2.2A | 2.2B | 2.2C |
|---|---|---|---|---|---|---|---|
| A | 28% | 13% | 80% | n | 78% | 69% | 4% |
| B | 71% | 6% | 14% | p | 22% | 30% | 96% |
| C | 0% | 76% | 9% | | | | |
| D | 2% | 5% | 96% | | | | |





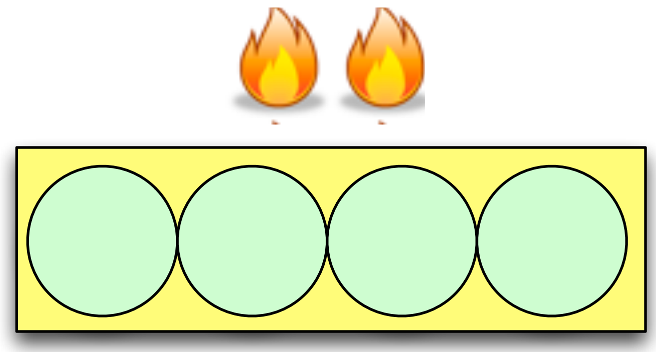
# The Equation of the Day

Combinitoric 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).

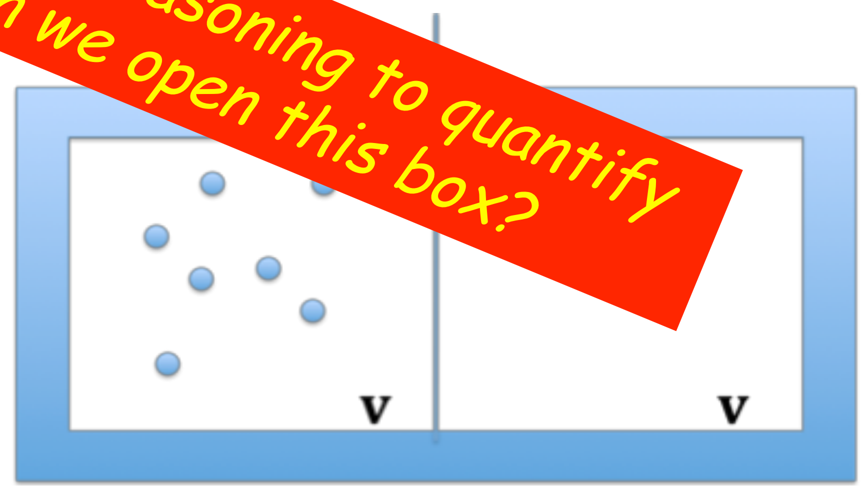
I have 2 packets of thermal energy.
How many ways are there
to distribute 2 packets?
*(i.e., How many microstates are there?)*



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 rem… and the system reaches equilibrium again, how … **entropy** of the gas compare to the entropy of t… …stem?

**Can we use the same kind of reasoning to quantify the change in entropy when we open this box?**

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 in MxMxM...xM (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

Logs convert multiplying to adding!

- 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.

$$x = e^{\ln(x)} \qquad x = \ln\left(e^x\right)$$

$$y = 10^{\log(y)} \qquad y = \log\left(10^y\right)$$

$$\log(2) = 0.3010$$
$$\log(e) = 0.4343$$
$$2^N = \left(10^{0.3010}\right)^N \approx 10^{0.3N}$$
$$e^x = \left(10^{0.4343}\right)^x \approx 10^{0.4x}$$
$$2^N = B$$
$$N \log 2 = \log B \Rightarrow N = \frac{\log B}{\log 2}$$