February 8, 2016

## $\square$ Theme Music: Doris Day

Que Sera, Sera
■ Cartoon: Bill Watterson

## Calvin \& Hobbes



HE SAYS HE HASNT USED A SLIDE RULE SINCE, BECAUSE HE GOT A FIVE-BUCK CALCULATOR THAT CAN DO MORE FUNCTIONS THAN HE COULD FIGURE OUT IF HIS LIFE DEPENDED ON IT.


Physics 132


# The Equation of the Day 

Entropy<br>(Information definition)<br>$$
S=k_{B} \ln W
$$

## Propose a formula

■ Suppose I have a block of matter with N two-state "Degrees of Freedom" (bins in which to place energy that can only hold 1 energy packet).
■ I have M packets of thermal energy. How many ways are there to distribute M packets?

■ Hint: "N choose M" =

$$
C_{N, M}=\frac{N!}{M!(N-M)!}
$$

## Foothold ideas: <br> Exponents and logarithms

■ Power law: $\quad f(x)=x^{2} \quad g(x)=A x^{7}$ a variable raised to a fixed power.
$\square$ Exponential: $\quad f(x)=e^{x} \quad g(N)=2^{N} \quad h(z)=10^{z}$
a fixed constant raised to a variable power.
■ Logarithm: the inverse of the exponential.

$$
\begin{array}{ll}
x=e^{\ln (x)} & x=\ln \left(e^{x}\right) \\
y=10^{\log (y)} & y=\log \left(10^{y}\right)
\end{array}
$$

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

