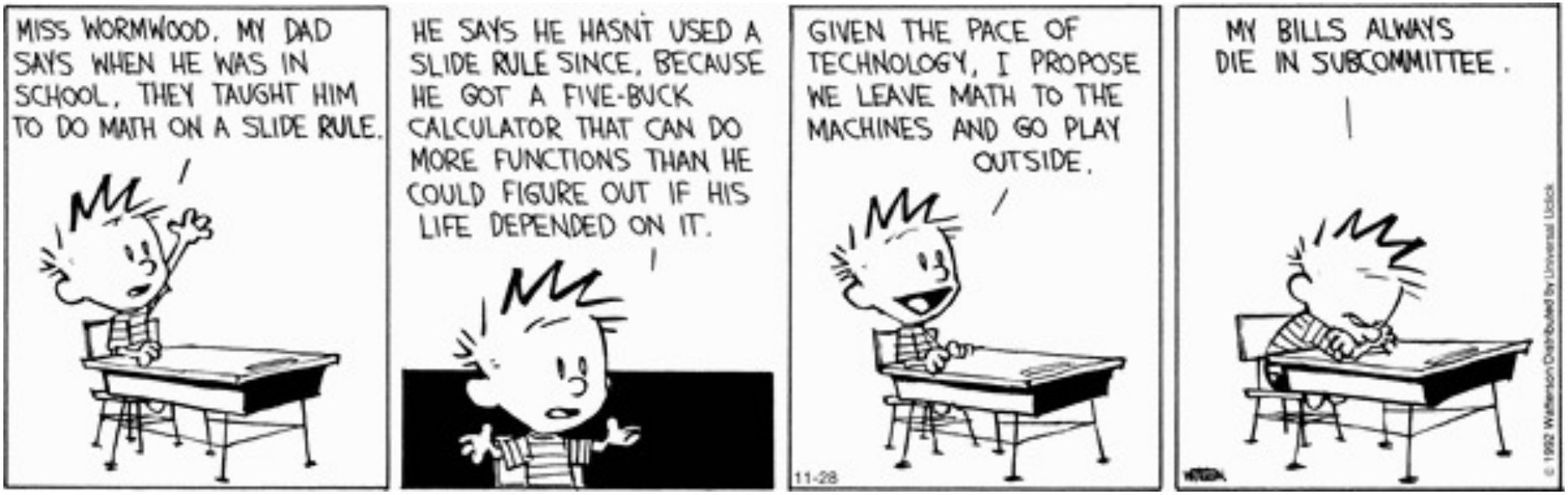
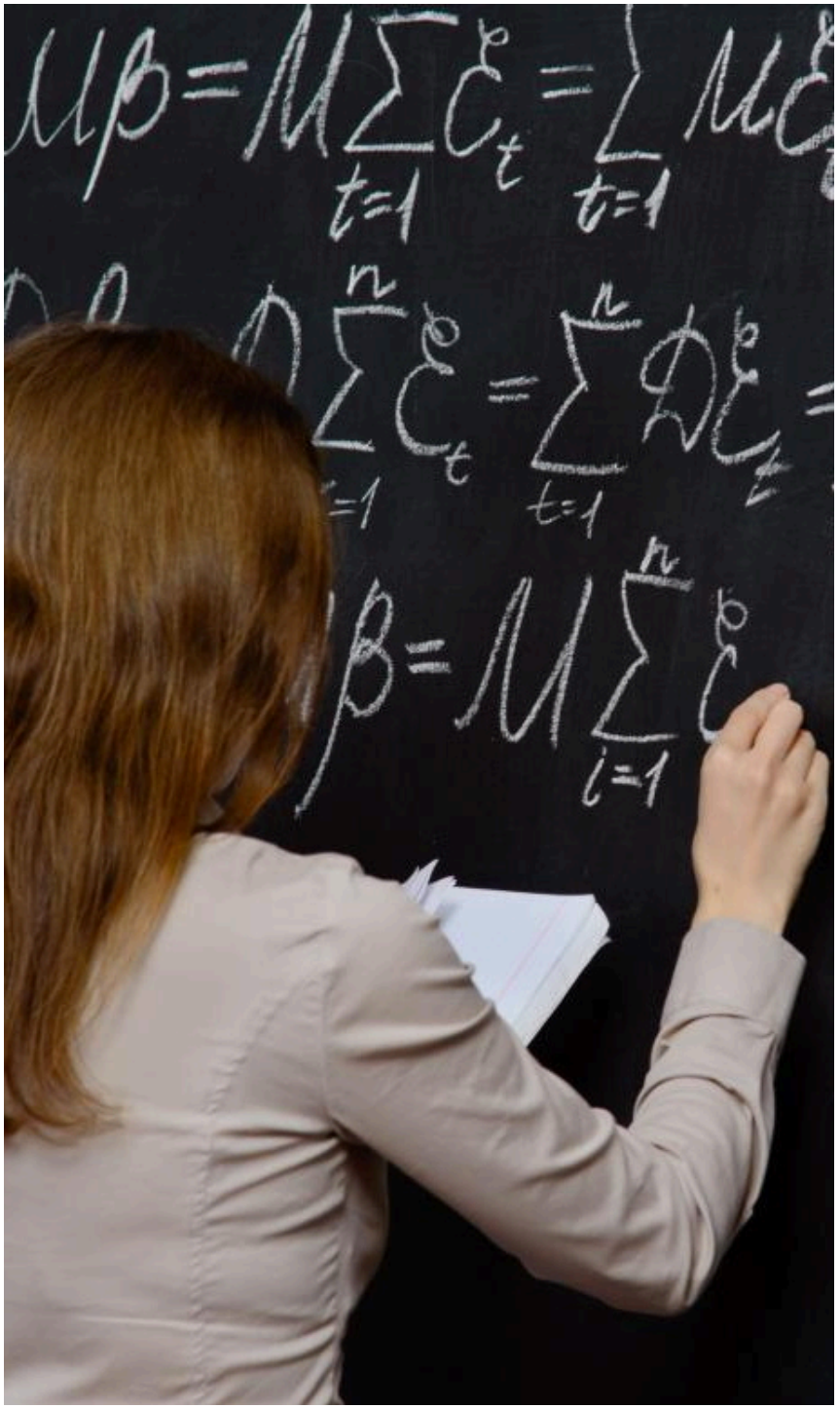
- **Theme Music: Doris Day**

  Que Sera, Sera

- **Cartoon: Bill Watterson**

  Calvin & Hobbes





The Equation of the Day

Entropy (Information definition)

$$S = k_B \ln W$$

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: 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.

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

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

Logs convert multiplying to adding!

$$\log(2) = 0.3010$$

$$\log(e) = 0.4343$$

$$2^N = \left(10^{0.3010}\right)^N \approx 10^{0.3N}$$

$$e^x = \left(10^{0.4343}\right)^x \approx 10^{0.4x}$$

$$2^N = B$$

$$N \log 2 = \log B \Rightarrow N = \frac{\log B}{\log 2}$$