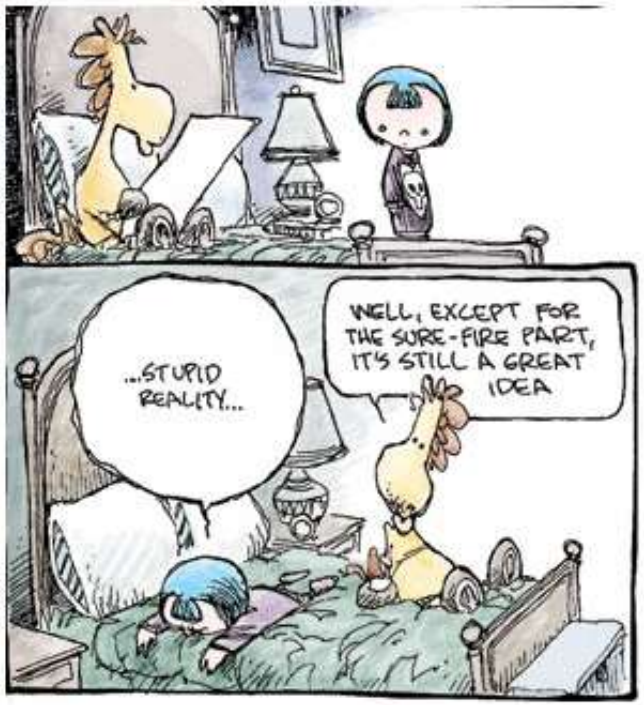
- **Theme Music:**
  Peggy Lee
  Fever
- **Cartoon:**
  Wiley
  Non-Sequitur



Definitions: Thermal energy

- Our model of matter as composed of many small moving particles allows us to extend energy conservation to include resistive forces.
- *The energy associated with the motion of a single object is **coherent**; all parts of the object move in the same way. The object has a net momentum associated with its kinetic energy.*
- *The internal energy of an object is **incoherent**. The molecules of the object are moving in all directions randomly. Although the individual molecules have kinetic energy and momentum, the net momentum of the object as a result of its thermal energy is zero.*

Definitions: Energy

- We can now expand our idea of energy to include more forms:
  - 1. Coherent energy of motion (**kinetic**) of the center of mass of an object: $\frac{1}{2} mv^2$
  - 2. Coherent energy of location relative to other objects (**potential**) of the center of mass.
  - 3. Incoherent internal energy of motion of the parts of an object (**thermal**)
  - 4. Submolecular energy of internal structure (**chemical**)

Definitions: Systems

- If total energy of everything conserved, conservation isn't useful. What matters is how energy is moved around in relation to parts we care about.
- Define systems:
  - ***Isolated*** – does not exchange energy or matter with the rest of the world.
  - ***Closed*** – exchanges energy but NOT matter with the rest of the world.
  - ***Open*** – exchanges both energy and matter with the rest of the world.

Exchange of Energy

- Energy can be transferred to or from a system (between "us" and "them") by
  - **Work** (coherent interaction via forces)
  - **Heat** (incoherent interaction via microscopic forces)

Equations

- Total energy of a system (a set of macroscopic objects)

$$E = KE + PE + U$$

Internal energy

- Exchanges of energy between the system and the rest of the universe

$$\Delta E = Q - W$$

Work done by the system on "them"

- Exchanges of energy between the system and the rest of the universe ignoring coherent mechanical energy

$$\Delta U = Q - W$$

How to keep it straight

- This can be very confusing!
  There are many possible circumstances
  and the first law changes its form as a result.
- Keep a focus on the micro model,
  where energies can lie, and how
  they can be exchanged according to
  the laws of physics can help you
  keep things straight.