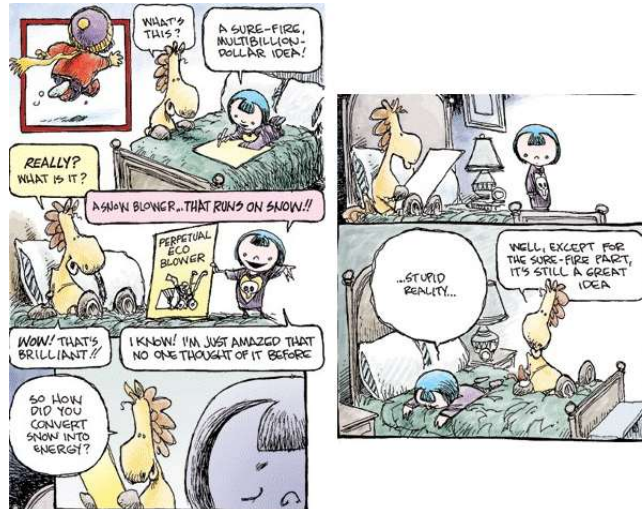


December 7, 2012

Physics 131

Prof. E. F. Redish

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



12/7/12

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1

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.

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2

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**)

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3

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.

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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)

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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

$$\Delta U = Q - W$$

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6

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.

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