Everyday Thermodynamics

Thermodynamics is generally considered a very abstract subject, but by connecting it to everyday life experiences, it is possible to make it less abstract. Here are some examples where thermodynamics can be related to our life experiences:

(i) **Ideal Gases:** An ideal gas is usually defined as one in which there are no intermolecular attractive forces, the volume of the molecules is negligible compared to the volume they occupy, and all collisions between atoms or molecules are perfectly elastic. I usually ask students to imagine that the molecules represent human beings. If they possessed these attributes would you consider them "ideal" human beings? That means that they have no feelings (attraction/repulsion) for other human beings; are perpetually in a hurry (no time to talk and enjoy life); and are always oblivious of the presence of others. The obvious answer is no, and here the traits that make a gas ideal are not what we would associate with "ideal" human beings.

(ii) **Ideal Mixtures:** Here the definition is that the molecules interact with molecules of other species exactly as they would with themselves (molecules of their own species). If we now consider these molecules to be once again human beings then here the attributes of an ideal mixture are indeed the attributes we associate with "ideal human beings." This would imply they treat others exactly as they treat themselves, a laudable quality for any person to have. Similar analogies can be drawn for Raoult and Henry Laws.

(iii) **Exploiting the First Law of Thermodynamics by Manipulating Numbers:** In recent years we have seen ads for so called "Amish Heaters." One such ad states that, "It uses just a trickle of electricity and saves you money (based on average U.S. electricity price) using only about 9¢ of electricity, yet it produces up to an amazing 4,606 BTU's on the high setting." Here you can ask the student to use the first law, $\Delta E = Q\text{-}W$. Assuming steady state, $\Delta E=0$, so $Q=W$, so the heat produced is the same for whatever device you use. There is no concept in thermodynamics for an efficient electric heater. If one converts 4606 Btu, it comes to 1.35kW-hr which is presumably the high setting. So the heater is providing what any other heater would do, assuming the price of electricity is 9 cents/kW-hr. No lies but very misleading!!!

(iv) **Using Second Law to Debunk Miracle Solutions:** Many car aficionado magazines advertise devices like miracle magnets that improve the mpg of a car by 300%. An efficient car today running on an internal combustion (IC) engine has a thermodynamic efficiency of between 40% and 50%. Since we all know nothing runs reversibly (especially a car that will have to have frictionless tires, and be incapable of stopping—compare with locomotive engines which try to make the motion approach the reversible limit, but we know what happens when a car comes in their way!). So there is very little room left to improve IC engines (certainly not 300%—maybe 10-15 %), which is one reason why hybrid and electric vehicles are being planned for the future to make cars more energy efficient. ❐

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