CHAPTER OVERVIEW

2: Energy

Here we inquire into the nature of energy in our next step on learning thermodynamics. Energy is probably one of the earliest words a person learns, so of course we know what it is! However, do we have a robust understanding that can be the subject of experimentation? And if so, do the experiments actually answer the questions put forth? Here is the problem- if I ask you to do an experiment to resolve "what is energy," you will propose measuring a change in energy, and not energy itself. Some of you may cry foul for having learned that energy per mole of a chemical can be defined by the Equipartition Theorem (discussed in Sec. 2.4 in case you haven't heard of it before):

$$U_m = \frac{1}{2}RT \cdot (degrees\ of\ freedom) \tag{2.1}$$

where we will call energy "U" for now, and the "m" subscript stands for "per mole". A degree of freedom is something like the vibration of a H_2 molecule or the ability of argon gas to translate in three dimensions. Certainly energy must exist if we have an equation for it! However, temperature is measured on the absolute Kelvin scale. As a result, I would contend that the Equipartition theorem does not provide an equation for energy, rather, it dictates the energy difference between something at temperature T relative to that same thing at 0 K.

Let's try again! What about Einstein's famous equation whereby energy is equal to mc^2, which describes how nuclear reactors generate electricity? Actually, mc^2 can be thought of as the energy difference between a state with mass compared to one with no mass. All of this is making me think that there may be no "energy" at all! Rather, there is only a change in energy; perhaps the subject of "what is energy" is more a problem for philosophers than for physical chemistry students. Furthermore, as you will learn in Chapter 4, we should not be concerned with energy at all as entropy is more important.
