The first law of thermodynamics simply states that energy is conserved. But it is useful to look at those two non-state variables work and heat. Both are changes in energy of a system, so we can write the first law as

$$\Delta U = Q + W \tag{1}$$

where U is the internal energy of the system, Q is the energy added to the system by heating, and W is the energy added to the system by working (or the work done on the system).

It is more convenient mathematically, however, to have a framework for talking about infinitesimal changes in the total energy:

$$dU = đQ + đW \tag{2}$$

The First Law may seem a bit obvious, and there isn't a whole lot to add to it right now, but you may be surprised how often it comes in useful, and how frequently students forget about it—presumably because it *is* so simple.

In your small groups: *Suppose an astronaught in vacuum (to avoid thermal conductivity) stretchs a rubber band and lets it snap repeatedly. What will happen to its temperature?*

> **Solution** This is obviously a First Law question, based on context. I have set up a situation where no energy is transfered by heating, so $Q = 0$. So we just need to determine which way the energy is flowing, to find the sign of ΔU, and then we need to reason about what that tells us about temperature.
>
> Clearly as I stretch a rubber band, I am doing work, so the internal energy of the band must increase. Internal energy tends to increase monotonically with increasing internal energy. The initial and final tensions in the rubber band are equal (zero), so since the internal energy increased, we expect the temperature to have increased. There are indeed scenarios that defy this expectation, most obviously, at a phase transition where the internal energy can increase without a change in temperature, or even go in the opposite direction.
>
> Note that rubber bands do some weird stuff, so the question of what happens when you stretch a rubber band but *do not let it snap shut* is considerably more challenging.