14.2: A Thermodynamics Analogy

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Readers may have noticed from time to time – particularly in Chapter 9 - that I have perceived some connection between parts of classical mechanics and thermodynamics. I perceive such an analogy in developing hamiltonian dynamics. Those who are familiar with thermodynamics may also recognize the analogy. Those who are not can skip this section without seriously prejudicing their understanding of subsequent sections.

Please do not misunderstand: The hamiltonian in mechanics is not at all the same thing as enthalpy in thermodynamics, even though we use the same symbol, *[Math Processing Error]*. Yet there are similarities in the way we can introduce these concepts.

In thermodynamics we can describe the state of the system by its internal energy, defined in such a way that when heat is supplied **to** a system and the system does external work, the **increase** in internal energy of the system is equal to the heat supplied **to** the system minus the work done **by** the system:

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From this point of view we are describing the state of the system by specifying its internal energy as a function of the entropy and the volume:

[Math Processing Error]

so that

[Math Processing Error]

from which we see that

[Math Processing Error]

and

[Math Processing Error]

However, it is sometimes convenient to change the basis of the description of the state of a system from *[Math Processing Error]* and *[Math Processing Error]* to *[Math Processing Error]* and *[Math Processing Error]* by defining a quantity called the enthalpy *[Math Processing Error]* defined by

[Math Processing Error]

In that case, if the state of the system changes, then

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I.e.

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Thus we see that, if heat is added to a system held at constant *volume*, the increase in the *internal energy* is equal to the heat added; whereas if heat is added to a system held at constant *pressure*, the increase in the *enthalpy* is equal to the heat added.

From this point of view we are describing the state of the system by specifying its enthalpy as a function of the entropy and the pressure:

[Math Processing Error]

so that

[Math Processing Error]

from which we see that

[Math Processing Error]

and

[Math Processing Error]

None of this has anything to do with hamiltonian dynamics, so let's move on.