Didn't do question 2 so total grade is 35/100

Question 1. 70/100

(a) Define a state parameter. Is a topological feature such as a knot in a shoelace a state parameter? Would Hess' Law (and the *First Law of Thermodynamics*) apply to a topological feature such as a knot in a shoelace?

Answer: Thermodynamic state parameters are entropy, pressure, volume, temperature etc. Entropy: a measure of the degree of randomness (disorder) of a system.

YES. Topological feature such as entanglement of shoelace can be considered a state feature. For example, polymers contain long chain of molecules, which can take a periodic arrangement known as crystalline polymer, or it can be in a random entanglement amorphous polymer, or it can be mixture of both. This entanglement can control the fundamental properties. Thus, knot in shoelace can be considered a state parameter. **-2**

Hess's states that net change of enthalpy is summation of change in enthalpy reaction. We may consider knot in a shoelace as randomness of a system. Randomness or enthalpy can dictate the configuration of the system, which is fundamental for any given system. Therefore, Hess's law will apply for shoelace.

(b) Make an argument that the transition being observed is a second-order transition. Define what parameter is considered that has a discontinuous second derivative.

Answer: Topological order parameter such as network linkage number and density were studied and evaluated for TIP4P/Ice and TIP4P/2005 models. From figure 3.(e), it is clear that network linkage number and density fluctuates at temperature Tc. Varialtion from Tc results in stability of network linkage number and density, which indicated that it is a second order transition. **Doesn't make sense. -8**

(c) If I throw computer cables on the floor, then try to pick them up I generally find that they are entangled. It requires significant energy to disentangle the cables though the pile will appear almost identical before and after disentanglement. Is this a first-order transition? How is this different from Neophytou's proposition for water molecules (tetrahedrally-associated molecules)?

Answer: This is a first order transition, because the cables were initially straight, which got tangled after throwing it. Therefore, when thrown, the straight cables which has some initial distortion/strain released some energy and moved to a lower energy (entangled) state. The more stable state can be revert back by absorption of more energy. Just like melting of ice and solidification of water, entanglement of cables is a first order transition.
Doesn't make sense -8

In the mentioned study, the weak B-B bonds in LDL and HDL phase is a chemical interaction of molecules. Therefore, it is a second order state.

(d) Is Neophytou's system ergotic? Has it reached equilibrium? How would you define equilibrium in this case?

Answer: Neophytou's system is ergotic because it is a reversible system and the driving force of the system is gradient of energy. When the system reaches lowest energy level it can attain a convergence point and on the other hand can also attain a high energy level depending on change in the state parameter.

Bad answer. Didn't demonstrate what ergotic, or equilibrium mean. -10

Neophytou's system reached equilibrium because its an ergotic system and it has a balance between the minimum and maximum energies. The equilibrium can be defined as conservation of energy based on 1^{st} law of thermodynamics.

(e) Consider the LDL and HDL "states". Do these two states have different entropies if calculated using the Boltzman equation?

Answer: According to Boltzmann equaltion

S = KB.lnΩ

Where S is the entropy of the system and Ω is the number of states present. HDL (High density liquid) has more states then LDL (Low density liquid). Therefore entropy would not be the same for LDL and HDL.

Knows Boltzmann but can't apply it to something new. -2