Recitation 3: Heat Engines

1- Claussius statement of 2nd Law is that a heat engine working in cycles, taking heat from a reservoir at temperature T_1 must reject “some” heat to a reservoir at a lower temperature T_2, to be able to do some work. Prove that if this is true, then Kelvin's statement must also be true, which says that heat can not by itself move from a colder body to a hotter body, without any input of some external work.

2- Consider an ideal gas going through a Carnot cycle, consisting of two adiabats and two isotherms. using the equations of state of the ideal gas, calculate the work done and heat taken in through this cycle and find out what is the efficiency of this engine.

Here efficiency = eta= W/Q= Net work done on surroundings/ Heat taken in at the higher temperature

Notice that we only have the heat taken in at higher temperature in the definition, and not the net heat exchanged, which will always be equal to the work done in a cycle. The heat rejected at lower temperature is like a lost energy to us. We wish to convert maximum amount of heat taken in to work, and reject minimum amount of heat to lower temperature.

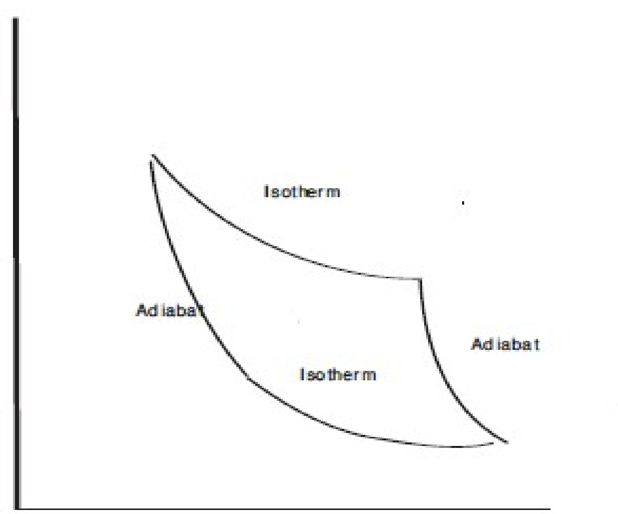

Figure 1: Carnot Cycle

Equations of state are

PV^{5/3}=constat (for adiabats only)
PV=nRT
E=3/2 nRT

3- Prove that no engine, working in cycle between two temperatures, can be more efficient than a Carnot engine. Use the reversible nature of Carnot's engine to show this.