Recitation 6

In this recitation, we will look at:

- Review:
  - Enthalpy: Internal energy "minus" the compressive energy:$H \equiv U + PV$
  - Entropy: Another State Function: For an ideal gas, we have:$\frac{dq_{rev}}{T} \equiv S = \frac{C_V}{T}dT \ + \ \frac{nR}{V}dV$, which is a state function: Its value is only a function of the initial and final states. This state function is an extensive property: it depends on the size of the system.For an ideal gas, we have:$dU = TdS - PdV$
  - Helmholtz free energy: Internal Energy "minus" the thermal energy. How much compression work is done on any body at constant temperature:$F \equiv U - TS$
  - Gibbs free energy: The internal energy of a system "minus" compressive and thermal energies:$G \equiv U + PV - TS$.This is the energy associated with the internal degrees of freedom of a system changed at constant pressure and temperature once you subtract thermal and compressive energies. Think of chemical energy, for example.
  - Brief introduction to the Second Law:"In an isolated system, during any process, the change in its entropy is always greater than zero"
- Questions regarding homework
- Sample Problems

Problem 1

A steel casting $[C_P = 0.5\frac{kJ}{kg\ K}]$ with a mass of $[40\ kg]$ and at a temperature of $[450^oC]$ is quenched in $[150\ kg]$ of oil $[C_P = 2.5\frac{kJ}{kg\ K}]$ at $[25^oC]$. Assume that there are no heat losses to the surroundings. Calculate the change in entropy in:

- The casting
- The oil bath

- The entire system ($casting + oil$)

Hints:

- Use the first law to obtain the final temperature of the composite system
- Use the expression for entropy:

$$m \triangle S = \int \frac{dQ}{T}$$

Problem 2

Obtain the expression for the change in entropy of an ideal gas as a function of (T,V), (T,P) and (P,V).