Instructions: You have a total of 50 minutes to complete this test. Answer each of the following questions completely providing details and correct SI units.

Time Start_______________ Time finish _____________pledged _________________

Constants: R=8.314 J/(K mol): water: c=4186 J/(^{0}C kg),L_f=3.33x10^5J/kg

[1] An ideal **3 dimensional diatomic gas with rotational modes realized but not vibrational modes** has the equation of state PV=nRT where n is the number of moles. **You may assume n=2 moles for this entire problem.**

(a) Calculate c_v, c_p and the adiabatic coefficient γ for this gas, providing numerical answers with correct SI units.

c_v=______________ c_p=___________________ γ=______________________

(b) Suppose that the ideal gas in (a) had an initial volume of V_i=1 m^3 and went through an **isothermal process (T=T_i=300 K)** which resulted in $V_f=2m^3$. **Providing correct SI units, calculate the following:**

P_i=____________________ Q=_____________________ W=________________ ΔU=___________________

(c) Suppose that the same gas went through an **isovolumeric (V=V_i)** process which resulted in T_f=600K where T_i=200 K with P changing from P_i to P_f. **Providing correct SI units, calculate the following:**

ΔU=_________________ W=_________________________ Q=_________________________

[2] An unknown solid material is observed to have a length of L_0=1 m at 0 ^{0}C and a length of L=1.5 m at 100 ^{0}C. **In your answers, be sure to use correct SI units.**
(a) Calculate the coefficient of linear expansion for this material.

α=___________

(b) A different material (**not the same material as in part a**) has a coefficient of volume expansion given by γ=5.0 x10^{-2} /C. Suppose a cube of this material with a volume V_0=1 m^3 is heated from 0 ^{0}C to 100 ^{0}C, calculate the work done when it expands against a constant pressure of P=1x10^5 Pa.

W=_____________________

(c) Suppose the material in (b) above has a mass of 500 kg and a specific heat at a constant pressure of c_p=20 /(kg ^{0}C). Calculate the heat supplied to the system.

Q=________________________

(d) Calculate ΔU when the material in (b) above is expanded (as in b) and simultaneously heated (as in c).

ΔU=________________________

[3] A heat engine produces 80 Joules of work for a heat input of 200 J.

(a) Calculate the efficiency of this engine.

ε=__________________

(b) How much heat does this engine reject?

Q_c=____________________

(c) Suppose this engine operates with a lower temperature of $T_c=100^0C$. If the engine has an efficiency equal to the Carnot efficiency, what is the temperature of the hotter reservoir?

T_H=_______________________

[4](a) If 1 kg of water at 0^0C is mixed with 1 kg of water at 75^0C, calculate the final equilibrium temperature of the mixture.

T_f=_______________________

[4](b) Calculate the change in entropy of the water as a result of the mixing described in part a, be sure to provide correct SI units.

ΔS=______________________

[4](c) If a 3 kg mass of ice at 0^0C melts to become water at 0^0C, calculate the change in entropy of the ice.

ΔS=______________________