Instructions: You have a total of 55 minutes to complete this test. Answer each of the following questions completely providing details and correct SI units.

Time Start_______________ Time finish _____________pledged _________________

[1] An ideal 3 dimensional monotonic gas has the equation of state $PV=nRT$ where n is the number of moles and R=8.314 J/(K mol). For this gas, it is known that the molar specific heat at constant volume is c_v= 3/2 R. You may assume n=1 mole here.

(a) Calculate c_p and the adiabatic coefficient γ for this gas.

C_p=___________________ γ=______________________

(b) Suppose that the gas went through an **isobaric process ($P=P_i$)** which resulted in $\Delta V=2V_i$ where V_i was the initial volume of the gas at the temperature T_i and pressure P_i. **In terms of P_i and V_i ,** calculate the following:

Q=__________________________

W=_________________________

ΔU=__________________________

(c) Suppose that the gas went through an **isothermal ($T=T_i$)** process which resulted in $\Delta V=2V_i$ with P changing from P_i to P_f. Calculate the following **(in terms of the thermodynamic variable T_i):**

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=1.01 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) Another material (not the same material as in part a) has a coefficient of linear expansion given by α=1x10^{-3} /C. Calculate the coefficient of volume expansion for this material assuming the material is isotropic.

γ=_________

(c) If a cube of the material in (b) above 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=_____________________

(d) Suppose the material in (b) above has a density of ρ=800 kg/m^3 and a specific heat at a constant pressure of c_p=2 J/(kg ^{0}C). Calculate the heat supplied to the system.

Q=________________________

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

ΔU=________________________

[3] A heat engine is reported to operate with 75% efficiency when the cold reservoir is at 0^0 C.

(a) Assuming this engine follows the Carnot cycle, what is the temperature of the hot reservoir (in K)?

T_H=_____________________

(b) Suppose the heat input to this engine was 50 J. Calculate the work done by this engine.

W=________________________

(c) Suppose the heat input to this engine was 50J. Calculate the heat rejected by this engine.

Q_c=_______________________

[4] For water, L_f=3.33x10^5 J/kg and c=4186 J/Kg ^{0}C.**In your answers, be sure to use correct SI units.**

(a) If a 7 kg mass of ice at 0^0C melts to become water at 0^0C, calculate the change in entropy of the system.

ΔS=______________________

(b) If 7 kg of water at 0^0C is mixed with 1 kg of water at 50^0C, calculate the final equilibrium temperature of the mixture.

T_f=_______________________

(c) Calculate the change in entropy of the water as a result of the mixing described in part b. Your result is positive quantity.

ΔS=______________________