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 diatomic gas with vibrational and rotational modes realized** has the equation of state $PV=nRT$ where n is the number of moles and R=8.314 J/(K mol). **You may assume n=1 mole for this entire problem.**

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

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 $T_i=300$ 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 200 ^{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=3.0 x10^{-1}/C. Suppose a cube of this material with a volume V_0=1 m^3 is heated from 0 ^{0}C to 200 ^{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 density of ρ=400 kg/m^3 and a specific heat at a constant pressure of c_p=200 /(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 is reported to operate with 65% efficiency (ε=0.65) when the cold reservoir is at 27^0 C.

(a) Suppose 100 Joules of work was done by this engine. What was the heat input to the engine?

Q_H=_____

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

T_H=_____

(c) Suppose the heat input to this engine had been Q_H=500 J. Calculate the work done by this engine.

W=_____

(d) Suppose the heat input to this engine was Q_H=500 J. 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 2 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=_____

(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=_____

(c) If a 2 kg mass of water at 0^0C freezes to become ice at 0^0C, calculate the change in entropy of the ice.

ΔS=_____