(1) Answer the following questions in details : (3% for each subproblems)

(a) What is the difference between the classical and the statistical approaches to thermodynamics ?

(b) What is the difference between intensive and extensive properties ?

(c) What is a quasi-equilibrium process ? What is its importance in engineering ?

(d) What is the zeroth law of thermodynamics ?

(e) Does the reference point selected for the properties of a substance have any effect in thermodynamic analysis ? Why ?

(f) Under what conditions is the ideal-gas assumption suitable for real gas ?

(g) An insulated room is heated by burning candles. Is this a heat or work interaction ? Take the entire room, including the candles as the system.

(h) On a hot summer day, a student turns his fan on when he leaves his room in the morning. When he returns in the evening, will the room be warmer or cooler than the neighboring room ? Why ? Assume all doors and windows are kept closed.

(i) How does a control volume differ from a closed system ?

(j) Define the coefficient of performance of a refrigerate in words. Can it be greater than unity ?

(2) A control mass undergoes a three-process power cycle with air (ideal gas) as the working fluid. The fluid undergoes (1) an isothermal compression, (2) a constant-pressure heating and (3) a polytropic process given by pv^k = constant, where $k = c_p/c_v$. Determine q (heat in Btu/lbm) and W (work in Btu/lbm) in each individual process. Assume the specific heats are constant and $p_1 = 1$atm, $T_1 = 70°F$, $p_2 = 6$atm, $R = 53.34\dfrac{ft\text{-}lbf}{lbm\text{-}°R}$, $k = 1.4$ and $c_v = 0.1716\dfrac{Btu}{lbm\text{-}°R}$. (20%)
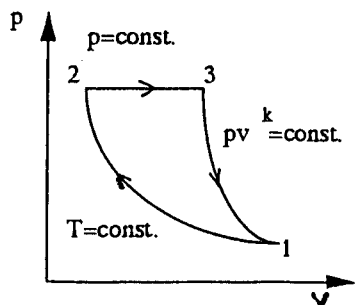
3. An isolated system has two phases , denoted by A and B , each of which consists of the same two substances , denoted by 1 and 2 . Show that the necessary conditions for equilibrium are

(1) the temperature of each phase is the same , $T_A = T_B$

(2) the pressure of each phase is the same , $p_A = p_B$

(3) the chemical potential of each component have the same value in each phase , $\mu_1^A = \mu_1^B$, $\mu_2^A = \mu_2^B$ (20 %)

4. How are the combustion and exhaust processes modeled under the air-standard assumptions ? (5 %)

5. In a boiler , heat is transferred from the products of combustion to the steam . The temperature of the products of combustion decreases from T_3 to T_4 while the pressure remains constant . The average constant-pressure specific heat of the products of combustion is $C_{p,av}$. The water enters at pressure P_1 , temperature T_1 and leaves at pressure P_2 , temperature T_2 . The ambient temperature is T_0 . Determine the reversible work and irreversiblity for the process per mass of water evaporated . Please explain how to obtaine every term of the answer . (25 %)