(航太所)

1. Write down the definitions of the following terms:

(a) reversible process (5%)

(b) coefficient of performance (5%)

(c) steady-state-flow process (5%)

(d) Gibbs equation and Gibbs function (5%)

(e) Otto cycle (5%)

2. Answer the following questions:

(a) State the third law of thermodynamics and explain it by means of the entropy concept. (7%)

(b) What is the primary presumption between the ideal and real gases? Try to answer it in accordance with the microscopic viewpoint. (8%)

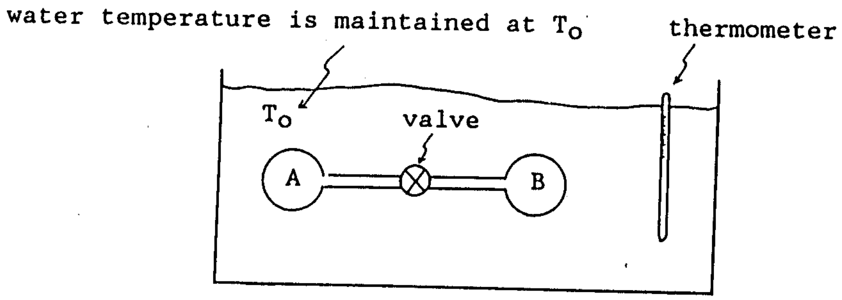
(c) A fact is that "mixing behavior increases the total entropy of the system even for an ideal gaseous mixture". Show theoretically this fact and discuss the meaning of your result. (10%)

3. Joule carried out a series of experiments which indirectly indicated that the internal energy of gases at low pressures was essentially a function of the temperature only.

(a) Assume internal energy u is function of temperature (T) and volume (v). According to Joule's experiment, what condition can you obtain? (shown in mathematical expression) (7%)

(b) Consider the set-up in Joule's experiment, as shown in the figure. Calculate the entropy change for the system. (8%)

3. (c) Due to the concept of availability (availabe energy), is there heat transfer to/from the water from/to the A and B bulbs? If yes, how do you explain this discrepancy? (10%)



Joule's experiment: When valve is open, gas in A expands into vaccum B. Bulbs A and B have the same volume.

4. A rigid, insulated tank consists of two compartments, each having a volume of 1 m^3, which are seperated by a valve. One compartment initially contains nitrogen at 600 kPa and 80°C, while the second one is evacuated.

(a) If a leak is formed in the second compartment, as a result, atmosphere air at 100 kPa and 20°C enters the tank. Calculate (i) the mass of air in the second compartment and (ii) the irreversibility of this process. (10%)

(b) Continue from (a). If the valve is then opened and the contents of the two compartments are allowed to reach equilibrium. Determine (i) the equilibrium temperature, (ii) the equilibrium pressure, and (iii) the irreversibility of the process. (15%)

Given:

the universal constant, $R = 8.314\ kJ/kg\text{-}mole \cdot K$

the heat capacity, $C_p = 20.8\ kJ/kg\text{-}mole \cdot K$

the molecular weight of air, $M_{air} = 28.8\ kg/kg\text{-}mole$