國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：熱力學【材光系碩士班乙組】　　題號：439006

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

1. (**25%**) (**a**) For an ideal gas mixture composed by Gas A and Gas B, the mole fraction (x_A) and volume fraction (y_A) are equivalent. One blends 0.3m^3 of Gas A and 0.7m^3 of Gas B to form an ideal gas mixture at same conditions and there is no interaction between A and B. Please calculate the values of enthalpy of mixing, entropy of mixing and Gibbs free energy of mixing, respectively. (10%) (**b**) Now the Gas A and Gas B are mixed through a steady state flow process: 1mole/s of Gas A at 600K and 1 atm is continuously mixed with 2 mole/s of Gas B at 450K and 1 atm. The temperature of product stream is of 400K and the pressure remains as 1 atm. Please determine the rate of heat transfer and rate of entropy generation of the process.(15%) Assume that Gas A, Gas B and the mixture are ideal gas with C_p=3.5R, the temperature of surrounding is maintained at 300K, and the kinetic and potential energy changes are negligible.

2. (**25%**) One mole of ideal gas with constant heat capacities (ie., independent of temperature) undergoes a change of state from state A (P_A=1 bar and V_B=12 m^3) to state B (P_B=12 bar and V_B= 1 m^3). (**a**) Please calculate the values of ***q*** and **W**, and the change in **U** and **H** if the process is a mechanically *reversible* isothermal compression. (8%) (**b**) Please calculate the values of ***q*** and **W**, and the change in **U** and **H** if the process is a mechanically *reversible* adiabatic compression followed by cooling at constant pressure. (8%) (**c**) Sketch the paths for process (a) and (b) on a single *PV* (Pressure-Volume) diagram. (4%) (**d**) If the processes (a) and (b) are now conducted irreversibly with 65% efficiency and with the same change of state, please determine the change in **U** and **H** for process (a) and (b).(5%) (Note: C_p=3.5*R* and C_v=2.5*R*, *R*=8.3146 m^{3}PaK^{-1}mol^{-1}, 1 bar=10^5 pa).

3. (**30%**) Figure 1 shows the Ag-Sn binary phase diagram.
(**a**) Please calculate the increase in entropy(*S*) when 50 grams of Ag are mixed with 5 grams of Sn to form a homogeneous binary alloy. The atomic weights of Ag and Sn are 107.9 (g/mol) and 118.7 (g/mol), respectively. (6%)
(**b**) Please write down the peritectic reactions at 725℃ (T_1) and 480℃(T_2) and indicate the reactant(s) and product(s) for the peritectic reactions. (4%)
(**c**) Please write down the eutectic reaction at 220℃ (T_3) and indicate the reactant(s) and products for the eutectic reactions. (2%)
(**d**) Sketch the free energies of mixing (ΔG^{mix}) for the liquid and phases as a function of composition at temperatures T_1,T_2 and T_3.(9%)
(**e**) Sketch the activities of Ag and Sn as a function of composition at temperatures T_1,T_2 and T_3. In each case give the standard state you have chosen. (9%)

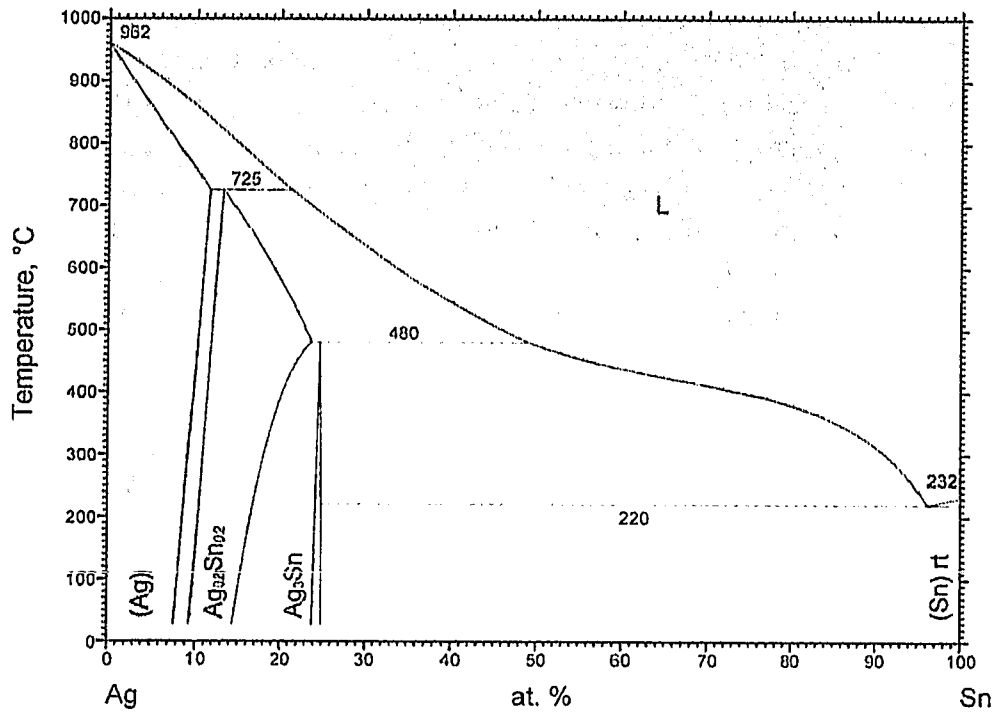

Figure 1 Ag-Sn binary phase diagram

4. (**20%**) The incredible Hulk would like to go ice-skating outdoors during winter time; however, the ice begins to melt once he stands on the ice. Given that the temperature of ice is **-0.5°C**, please estimate the weight of Hulk (kg) by using the Newton's Second Law $F=mg$. (Note: the specific volume of water and ice at 0°C are 0.00100 m^3/kg and 0.00109 m^3/kg, the heat of fusion for ice is 333.5 kJ/kg, the contact area between Hulk and ice is 0.001 m^2, 1atm=1.01324×10^5 (N/m^2) and g=9.81 (m/s^2)).