國立中山大學107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）　

請於答案卷上依序做答，並清楚標明題號

1. **(25%)** **(a, 4%)** The thermodynamic properties *U, H, A* and *G* are known of the variables, *T, S, P* and *V*. For a homogeneous fluid of constant composition, there are four fundamental property relations. Write down the four relations of *dU, dH, dA* and *dG*. **(b, 2%)** Define the heat capacity at constant volume (C_v) and at constant pressure (C_p). **(c, 5%)** The complete differential internal energy U can be written in terms of the partial derivative $dU=\left(\frac{\partial U}{\partial V}\right)_T dV+\left(\frac{\partial U}{\partial T}\right)_V dT$, derive the relation $C_p=C_v+R$ for one mole of ideal gas. **(d, 5%)** Define the partial molar property ($\overline{M_i}$), the chemical potential (μ_i), the fugacity (f_i), the activity (a_i) and activity coefficient (r_i) of species *i* in a solution. **(e, 4%)** Define the Raoult's law and Henry's law, respectively. **(f, 5%)** Draw two schematic figures that illustrate the vapor pressure of a component of a binary solution (A-B) exhibiting positive deviation and negative deviation from Raoultian behavior, respectively.

2. **(25%)** **(a, 5%)** Draw a schematic *T-x* (temperature-composition) phase diagram for a binary A-B system with one liquid phase (L), two terminal solid phases (α and β), one eutectic reaction and one peritectic reaction . Please label all phase regions. **(b, 5%)** Figure 1 shows the Ag-Sb binary phase diagram. Please calculate the change of entropy (△S) when 100 grams of pure silver (Ag) is mixing with 5 grams of pure antimony (Sb), to form a homogeneous binary alloy. The atomic weights of Ag and Sb are 107.9 (g/mol) and 121.7 (g/mol), respectively. **(c, 5%)** Write down the eutectic reaction and the peritectic reaction in figure 1 at 485 ° C (T_1) and 702.5° C (T_2), respectively. **(d, 5%)** Sketch the Gibbs free energies of mixing (ΔG^{mix}) for the liquid and phases (i.e., the (Ag), (Sb), ε and ζ) as a function of composition at temperatures T_1 and T_2. **(e, 5%)** Sketch the activities (a_i) of Ag and Sb as a function of composition at temperatures T_1 and T_2. Note that the standard state of each case needs to be given.

3. **(15%)** A rigid and isolated container with volume of 10 (Liter, *L*) is divided by a divider into two parts: 2.5 (*L*) and 7.5 (*L*). At very beginning, one part (2.5 (*L*)) is filled with one mole of A gas at 300 K and 1 bar; while the other part (7.5 (*L*)) is filled with two moles of B gas at 600 K. And both A and B gases follow the ideal gas law. As the divider is removed, A and B gases are allowed to mix together. Please calculate the following terms: **(a, 3%)** the temperature of gas mixture. **(b, 3%)** the pressure of gas mixture. **(c, 3%)** the change in entropy. **(d, 3%)** the change in Gibbs free energy. **(e, 3%)** the change in enthalpy. (Note: $C_p=3.5R$ and $C_V=2.5R$, $R=8.3146\ m^3PaK^{-1}mol^{-1}$, 1 bar=$10^5$ pa).

4. **(15%)** A Carnot engine, rated at 10^5 kW, generates steam from a heat reservoir at 800 K and discards heat to a cold reservoir at 300 K. **(a, 5%)** What is the entropy change of the heat reservoir at 300K? **(b, 5%)** What is the rate at which heat is absorbed from the heat reservoir and discarded to the cold reservoir? **(c, 5%)** A practical engine operates between the same heat and cold reservoirs but with an efficiency which is 50% of that of a Carnot engine.

背面有題　試題隨卷繳回

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5. **(20%)** A steel casting weighing 4 kg has an initial temperature of 400°C; 40 kg of water initially at 25℃ is contained in a perfectly insulated steel tank weighing 5 kg. The steel casting is immersed in the water and the system is allowed to reach equilibrium. **(a, 5%)** What is the final equilibrium temperature? **(b, 5%)** What is the entropy change of the steel casting? **(c, 5%)** What is the entropy change of the water? **(d, 5%)** what is the *total* entropy change ($\triangle S_t$)? (Note: $C_{p,steel}$=0.5 (kJ/kg) and $C_{p,water}$=4.2 (kJ/kg)).

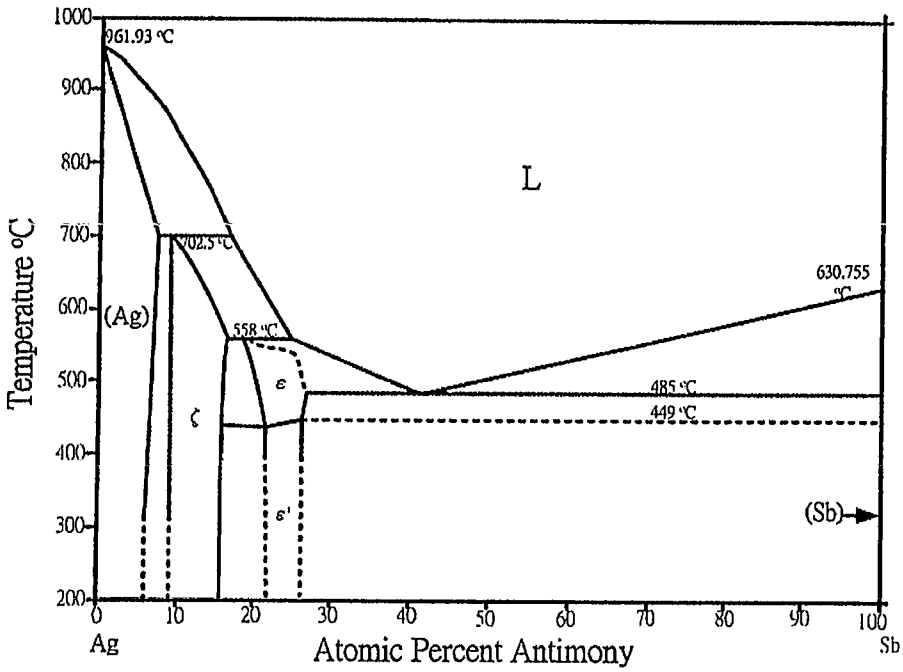

Figure 1 Ag-Sb binary phase diagram.

	Conversion factors and gas constant
Pressure	1 bar= 10^5 $Kgm^{-1}S^{-2}$= 10^5 Pa=0.986923 atm= 14.5038 psia =0.986923 atm
Energy	1 J= 1Kgm^2s^{-2}= 1Nm=1m^3Pa=0.239006 cal
Gas constant	R= 8.314 $Jmol^{-1}K^{-1}$ =8.314 $m^3Pamol^{-1}K^{-1}$=83.14 $cm^3barmol^{-1}K^{-1}$