淡江大學97學年度碩士班招生考試試題

系別：化學工程與材料工程學系　　　科目：化 工 熱 力 學

准帶項目請打「V」	
	簡單型計算機

本試題共 1 頁，4 大題

Questions (a) 10 %, Questions (b) 15 %

1. The attached figure is enthalpy-concentration diagram for aqueous sulfuric acid at 0.1MPa. Reference state: the enthalpies of pure liquids at 0°C and their vapor pressures are zero. Knowing that the density of sulfuric acid is about 1.840, you are required to answer the questions as described below:
   (a) When you prepared an aqueous sulfuric acid solution by mixing pure water and sulfuric acid, should you gradually pour water into sulfuric acid, or, contrarily, sulfuric acid into water?
   (b) Give your further physical explanation to answer of (a).

2. You have to read out the data values that you need from the same previous figure in your calculation for the questions as described below. You are demanded to do the following steps for each question
   (1) In the diagram, mark the data points that you read with small circles, and give for each one of them the notations like "A", or "B" etc.
   (2) At the beginning of your answer, write down the data you have just read out in the diagram, like "A = 0.12 kJ/kg" etc. and write down the physical state of the points like "A is pure ethanol, liquid, at 40°C and 0.3MPa" etc.
   (3) Give the equations that you need, and explain their physical meaning.
   (4) Finally, calculate the values that are required in your answer.
   The questions are
   (a) Calculate the heat evolved when 100g of pure sulfuric acid, liquid, at 0°C and 0.1MPa is added to 100g of water, liquid, at 21.1°C and 0.1MPa to form a solution at 37.8°C and 0.1MPa.
   (b) Calculate the heat evolved when the solution prepared in part (a) is diluted with an additional 100g of water, liquid, at 21.1°C and 0.1MPa to form a dilute solution at 37.8°C and 0.1MPa.

3. Knowing that (1) the 1st law of thermodynamics: $dU = dq + dw$, (2) internal energy U is a state function of temperature T and volume V, (3) entropy from the 2nd law of thermodynamics is estimated as $dS = dq_{rev} / T$, and (4) ideal gas equation $pV_m = RT$, you want to derive, for ideal gas, the equation $dS_m = \frac{C_{V,m}}{T}dT + \frac{R}{V_m}dV_m$, called equation X, where subscript "m" means molar.
   (a) Besides the above 4 already known laws or relations, what are the further relations and / or assumptions you need for the derivation of equation X?
   (b) Derive equation X.

4. Hydrogen has an auto ignition temperature of 853K. Hydrogen is to be adiabatically and reversibly compressed from 3bar and 300K to a high pressure. To avoid accidental explosion in case of a leak, the maximum allowed exit temperature from the compressor will be 800K.
   (a) Transform the previous equation X to
   $$dS_m = \frac{C_{p,m}}{T}dT - \frac{R}{p}dp$$
   (b) Compute the maximum pressure that can be obtained in the compressor, assuming hydrogen to be an ideal gas with $C_p = 29.088 - 0.192 \times 10^{-2}\,T + 0.4 \times 10^{-5}\,T^2 - 0.870 \times 10^{-9}\,T^3$ J mol^{-1} K^{-1}, noting that here C_p is not a constant, but a function of temperature.