

國立臺灣科技大學 110 學年度碩士班招生試題

系所組別：材料科學與工程系碩士班甲組

科目：物理化學

(總分為 100 分)

1. (20 points) A 17.5 g mass of ice at 273 K is added to 125 g of H₂O (l) at 325 K at a constant pressure. Assume $C_{p,m}(\text{H}_2\text{O}(l))$ (heat capacity per mole at constant pressure) = $C_{p,m}(\text{H}_2\text{O}(s)) = 75.3 \text{ J/Kmol}$; $\Delta H_{\text{fusion}}^{\text{ice}}(\text{H}_2\text{O}) = 6010 \text{ J/mol}$.
- (1) Determine the final state of the system (ice or liquid water) with temperature. (5 points)
 - (2) Calculate ΔS for the ice. (5 points)
 - (3) Calculate ΔS for water. (5 points)
 - (4) Calculate the overall ΔS for the process to determine the process is spontaneous or nor. (5 points)
2. (20 points) 1.75 mole of an ideal gas with $C_{v,m} = 3R/2$ (heat capacity per mole at constant volume) is expanded adiabatically against a const external pressure of 1 bar. The initial temperature and pressure are 290 K and 19.5 bar. The final pressure is 1 bar.
- (1) Fine the final temperature. (8 points)
 - (2) Calculate q (heat), w (work), ΔU (change in internal energy) and ΔH (change in enthalpy) for the process. (12 points)
3. (10 points) Assume that the equation of state for a gas can be written in the form $P(V_m - b(T)) = RT$. Derive an expression for $\beta = \frac{1}{V} \left(\frac{\partial V}{\partial T} \right)_P$ and $\kappa = -\frac{1}{V} \left(\frac{\partial V}{\partial P} \right)_T$ for such a gas in terms of $b(T)$, $db(T)/dT$, P , and V_m . Where $b(T)$, β , κ , z , P , T and V are represented finite size of molecules, isobaric volumetric thermal expansion coefficient, compression factor, isothermal compressibility, pressure, temperature and volume, respectively.



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4. The vapor pressures of C_2H_5OH and H_2O at $20^\circ C$ are as follows:

Weight percent C_2H_5OH	$P_{C_2H_5OH}$ (torr)	P_{H_2O} (torr)
0	0	17.5
20.0	12.6	15.9
40.0	20.7	14.7
60.0	25.6	14.1
80.0	31.2	11.3
100.0	43.6	0

For a solution of 40 percent C_2H_5OH by weight,

- (1) Find the activity of each component (10 points)
- (2) Find the activity coefficient of each component (10 points)

Please take the pure substance as the standard state for each component.

5. Please write the equation that relates the temperature to the amount of gas adsorbed on a solid's surface, and solve for enthalpy change for the adsorption of 40 cm^3 of CO (measured at $0^\circ C$ and 1 atm) by 1 g of silica at $60^\circ K$, and 8 cm^3 at $298^\circ K$. (10 points)
6. Given that Henry's law constant for the solubility of oxygen gas in water is 3.30×10^7 torr at $25^\circ C$, please calculate the solubility of oxygen under room temperature. Consider air to be 20% O_2 at room temperature. (10 points)
7. The rate of a first order reaction increases from $1.5 \times 10^{-2}\text{ sec}^{-1}$ to 4.6 sec^{-1} at $260^\circ C$ when a catalyst is added to the reaction. Calculate the decrease in the activation enthalpy H , assuming S^\ddagger , the activation entropy, is not affected by the catalyst. (10 points)

