國立臺灣科技大學 109 年度產業碩士專班招生(秋)試題

班　　別：新穎薄膜暨電池材料

科　　目：物理化學

(總分為 100 分)　　不得使用計算器

物理化學

1. 1 mole of an ideal gas with $C_{v,m} = 3R/2$ undergoes the transformations described in the following list from an initial state described by $T = 500\ K$ and $P = 10^5\ Pa$. Calculate q, w, ΔU, ΔH and ΔS for each stages. Please express answers with R and ln2.

(a) The gas is heated to $1000\ K$ at a constant external pressure of $10^5\ Pa$. (10 points)

(b) The gas is heated to $1000\ K$ at a constant volume corresponding to the initial volume. (10 points)

(c) The gas undergoes a reversible isothermal expansion at $500\ K$ until the pressure is half of its initial value. (10 points)

where $C_{v,m}$, T, P, q, w, U, H and S are represented molar heat capacity at constant volume, temperature, pressure, heat, work, internal energy, enthalpy, and entropy.

2. An ideal solution is made from m_1 mol of benzene and m_2 mol of toluene. Calculate ΔG_{mixing} and ΔS_{mixing} at $500\ K$ and 1 bar pressure. Is mixing a spontaneous process? (10 points)

where G and S are represented Gibbs free energy and entropy.

3. (a)Assume that the equation of state for a gas can be written in the form $P(V_m\text{-}b(T)) = RT$. 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. (15 points)

(b) Show that $T\beta = 1 + T\left(\frac{\partial \ln z}{\partial T}\right)_P$ and $P\kappa = 1 - P\left(\frac{\partial \ln z}{\partial P}\right)_T$. (15 points)

(c) At what temperature does the slope of the z versus P curve as $P \to 0$ have its maximum value for a van der waals gas? what is the value of the maximum slope? (10 points)

where β, κ, z, P, T and V_m are represented isobaric volumetric thermal expansion coefficient, compression factor, isothermal compressibility, pressure, temperature and volume per mole.

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4. Please drive

(a) $\left(\frac{\partial U}{\partial S}\right)_V = T$ and $\left(\frac{\partial U}{\partial V}\right)_S = -P$ (10 points)

(b) $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$ (10 points)

where *S, P, T* and *V* are represented entropy, pressure, temperature and volume.