

淡江大學 105 學年度碩士班招生考試試題

32-1

系別：化學工程與材料工程學系 B 組

科目：物理化學

考試日期：3 月 5 日(星期六) 第 2 節

本試題共 5 大題，共 2 頁

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- (30 %) A sample of 2.0 moles of H_2 gas is expanded isothermally at $25^\circ C$ from $4.0 m^3$ to $20.0 m^3$, if the process is going through
 - a reversibly process, calculate the values of heat (Q), work (W), the changes in enthalpy (ΔH), Gibbs energy (ΔG), entropy of system (ΔS_{sys}), and entropy of surrounding (ΔS_{surr}). (Gas constant, $R = 8.314 J/K \cdot mol$)
 - against a constant external pressure (the external pressure is equal to the final pressure of the gas). Calculate the values of Q , W , ΔH , ΔG , ΔS_{sys} , ΔS_{surr} .
- (20%) There is a container of volume $1,000 cm^3$ that is divided into two compartments of equal size. In the left compartment there is argon (one kind of gas) at 100 KPa and $0^\circ C$; in the right compartment there is neon (the other kind of gas) at the same temperature and pressure. Calculate the entropy and Gibbs energy of mixing when the partition is removed and those two gases can be mixed well. Assume that the gases are ideal gases.
- (20%) There is one reaction as $A \rightleftharpoons B$. When we consider this reaction approaches equilibrium in which A forms B and both forward and reverse reactions are first order. The rate of reaction (v) for both directions are as below:
$$\begin{array}{ll} A \rightarrow B & v = k_1 [A] \\ B \rightarrow A & v = k_2 [B] \end{array}$$
Derive an expression for the concentration of A as a function of time, when the initial concentration of A is $[A]_0$, and no B is present initially (that is to say, $[A] = [A]_0$, and $[B] = 0$ at $t = 0$). Also, at all the time $[A] + [B] = [A]_0$
- (15%) Considering the equilibrium between liquid and vapor phases of an acetone (A)/methanol (M) solution at $60^\circ C$ and 1 atm, it was found that $x_A = 0.4$ when $y_A = 0.61$. Calculate the activities and activity coefficients of both components in this solution on the Raoult's law basis. The vapor pressure of the pure components at this temperature are: $p_A^* = 100 KPa$ and $p_M^* = 75 KPa$. (Note: x_A is the mole fraction in the liquid and y_A is the mole fraction in the vapor. The definition of activity is $a_i = p_i/p_i^*$. The activity coefficient is defined $\gamma_i = a_i/x_i$).
- (15%) Regarding the photon emission, the energy of emission can be described by Bohr frequency condition as below:

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32-2

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$$\Delta E = h\nu$$

where h is Planck's constant ($h = 6.626 \times 10^{-34}$ J s); ν is radiation frequency.

In general, $\nu = c/\lambda$, c is the speed of light in a vacuum ($c = 3.0 \times 10^8$ m/s); λ is the wavelength.

(1) calculate the energy per photon for radiation of wavelength of 600 nm.

(2) If a proton (質子) is accelerated, to what speed (u) must be for this proton

to have a wavelength of 3.0 cm? (Note: using the de Broglie relation: $\lambda = h/P$, P is the linear momentum $P = m_p u$; where m_p is the mass of a proton of 1.673×10^{-27} kg)