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淡江大學 106 學年度日間部轉學生招生考試試題

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系別：化學工程與材料工程學系三年級　　科目：物理化學

考試日期：7 月 21 日(星期五) 第 2 節　　本試題共 5 大題，2 頁

1. (20%) For a gas from initial state Vi = 1.0 dm^3, n = 1 mol, and T = 298 K, it undergoes isothermal reversible expansion to final state Vf = 4.0 dm^3.
   (a) If the gas is an ideal gas, calculate (a) the work done (W), (b) the heat transferred (Q), (c) the change in internal energy (ΔU), (d) the change in entropy of the system (ΔS).
   (b) If the gas is a van der Waals gas in which a = 0, and b = 5.11×10^{-2} dm^3, calculate the work done (W)　(Hint: $p = nRT/(V-nb) - a(n/V)^2$)

2. (20%) The vapor pressure of benzene (molecular formula is C_6H_6) at 20°C is 10 kPa, and that of methylbenzene (molecular formula is C_6H_5-CH_3) is 2.8 kPa at the same temperature. Assume the mixture of the both benzene and methylbenzene becomes an ideal solution and it obeys Raoult's law. What is the vapor pressure of a mixture of equal masses of each component?　(Hint: you can assume the same mass for each component to become a mixture).

3. (20%) There is one reaction measured the rate constants for the elementary bimolecular gas-phase reaction over a range of temperatures as below table.　Determine the Arrhenius parameters A and Ea, where A is the frequency factor, and Ea is the activation energy.

T/K	295	223	218	213	206	200	195
k_r/(10^6 dm^3 mol^{-1} s^{-1})	3.55	0.494	0.452	0.379	0.295	0.241	0.217

4. (20%) In a gas reaction　2 A + B ⇆ 3 C + 2 D, it was found that, when 1.0 mol A, 2.0 mol B, and 1.0 mol D were mixed and allowed to come to equilibrium at 25°C, the resulting mixture contained 0.90 mol C at a total pressure of 1.0 bar. Calculate
   (a) The mole fractions of each species at equilibrium,
   (b) K (the equilibrium constant)
   (c) $\Delta_r G^{\ominus}$ (the standard Gibbs energy of formation)

5. (20%) Regarding the photon emission, the energy of emission can be described by Bohr frequency condition as below:

$$\Delta E = h\nu$$

where h is Plank's constant (h = 6.626X10-34 J s); ν is radiation frequency.

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

(a) Calculate the energy per photon for radiation of wavelength of 550 nm.

(b) 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)