國立成功大學 106 學年度碩士班招生考試試題

系　所：化學系

考試科目：物理化學

考試日期：0214，節次：1

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

說明：1. **請依題序作答並標明題號，計算題需寫出計算過程，只寫答案不給分**

2. ln(2)= 0.693, ln(10)= 2.3, ln(0.46)= -0.78

(一)單選題 12 題，每題 5 分，共 60 分，答錯倒扣 1 分

(1) The standard emf of cell　Pt(s) | H_2 | HBr(aq) | AgBr(s) | Ag(s)　 is given by

E^o/ V = 0.071–5.00 x 10^{-4} (T/K–298) – 3.45 x 10^{-6} $(T/K–298)^2$

Evaluate the $\Delta_r S^o$ (in J K^{-1} mol^{-1}) at 298 K

(A)-48.2　(B)-56.3　(C)-65.8　(D)-72.5　(E)-81.7

(2) The excess Gibbs free energy of solution of methylcyclohexane (MCH) and tetrahydrofuran (THF) at 303.15 K was found to fit the expression

G^E= RT x (1-x) [0.48-0.11(2x-1)+0.02$(2x-1)^2$]

, where x is the mole fraction of MCH.　Calculate the Gibbs free energy of mixing (in RT) when a mixture of 2.0 mole of MCH and 2.0 mole of THF is prepared.

(A)-0.57　(B)-2.65　(C)-5.22　(D)-6.35　(E)-2.3

(3) 3 moles of van der Waals gas with a= 3.6 atm L^2/mol^2 and b= 0.5 L/mol is compressed from 20.0 L to 10.0 L at 300 K.　Calculate ΔU (in J) for the process.

(A)-1.62　(B)-18.2　(C)-34.4　(D)-72.9　(E)-164.1

(4) Calculate ΔS (in J/K) in Problem 3.

(A)-6.4　(B)-13.2　(C)-19.4　(D)-28.9　(E)-36.3

(5) The pre-exponential factor for a certain bimolecular gas-phase reaction is 4.6 x 10^{12} L mol^{-1} s^{-1}, and its activation energy is 10.0 kJ/mol.　What is the enthalpy of activation (in kJ/mol) at 300 K?

(A)3.2　(B)5.0　(C)6.8　(D)7.5　(E)8.3

(6) Consider the reaction　A → P　with autocatalysis, where rate = k[A][P] and [A]=$[A]_o$, [P]=$[P]_o$ at t=0. Derive kt as a function of [A] and [P].

(A)($[A]_o$+$[P]_o$) ln{$[A]_o$[P]/([A]$[P]_o$)}　(B)$([A]_o+[P]_o)^{-1}$ ln{[A]$[P]_o$/($[A]_o$[P])}

(C)$([A]_o+[P]_o)^{-1}$ ln{$[A]_o$[P]/([A]$[P]_o$)}　(D)($[A]_o$+$[P]_o$) ln{[A]$[P]_o$/($[A]_o$[P])}

(E)$([A]_o+[P]_o)^{-2}$ ln{[A]$[P]_o$/($[A]_o$[P])}

(7) Calculate the half-life of A if $[A]_o$= 1000 $[P]_o$ in Problem (6).

(A)6.9$(k[A]_o)^{-1}$　(B)5.4$(k[A]^2{}_o)^{-1}$　(C)4.6 $k^{-1}[A]_o$　(D)4.6$(k[A]_o)^{-1}$　(E)6.9$(k[A]^2{}_o)^{-1}$

(8) K-40 decays by 2 processes:

$${}^{40}_{19}K \rightarrow {}^{40}_{20}Ca + \beta \quad (90\%) \quad \text{(rate constant } k_1)$$

$${}^{40}_{19}K \rightarrow {}^{40}_{18}Ar + \beta^+ \quad (10\%) \quad \text{(rate constant } k_2)$$

The half-life for potassium decay is 1.3 x 10^9 years.　Determine k_2 (in 10^{-11} yr^{-1}).

(A)2.4　(B)3.5　(C)4.6　(D)5.3　(E)6.8

(9) What's the ground state term symbol for an oxygen atom?

(A)$^2P_{3/2}$　(B)$^1S_0$　(C)$^2P_{1/2}$　(D)$^3P_2$　(E)$^4S_{3/2}$

(10)An unnormalized wave function for a light atom rotating around a heavy atom to which it is bonded is $\Psi(\phi) = e^{i\phi}$ with $0 \leqq \phi \leqq 2\pi$. What's the probability of finding the light atom between $\phi=\pi/2$ and $\phi=3\pi/2$?

(A)π　(B)1/2　(C)1/4　(D)$\pi/6$　(E)1/3

(11)What's the kinetic energy in Problem 10?

(A)$2\hbar^2/I$　(B)$\hbar^2/2I$　(C)$\hbar^2/4I$　(D)$4\hbar^2/I$　(E)$3\hbar^2/4I$

(12)Calculate the expectation value of momentum for a particle in a box with the wave function

$$\Psi(x) = (2/L)^{1/2} \sin(3\pi x/L)$$

(A)$3\hbar/L$　(B)$\hbar/3L$　(C)0　(D)$6\hbar/L$　(E)$\hbar/6L$

(二)計算與作圖題 3 題，共 40 分

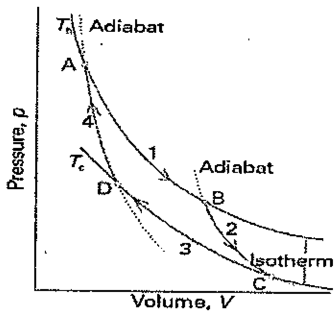
(1)Consider a Carnot cycle, where n moles of ideal gas is the working fluid.

(a)Calculate the area enclosed by the curves of the P-V plot in terms of T_h, T_c, and q_h.

(b)Derive T_h/q_h as a function of T_c and q_c.

(c)Plot entropy vs. temperature for a Carnot cycle and indicate the locations of A, B, C, and D.

(18 %)



(2)Plot μ vs. T to show the effect of increasing pressure on the freezing point if $V_{m,solid} < V_{m,liquid}$.　(6 %)

(3)Suppose that the wave function for a system can be written as

$$\Psi(x) = (3/16)^{1/2}\phi_1(x) + (3/8)^{1/2}\phi_2(x) + [(2+3^{1/2}i)/4]\phi_3(x)$$

and that $\phi_1(x)$, $\phi_2(x)$ and $\phi_3(x)$ are eigenfunctions of the operator $\hat{E}_{kinetic}$ with eigenvalues E_1, $2E_1$, and $4E_1$, respectively.

(a)Verify that $\Psi(x)$ is normalized.

(b)What are the possible values you could obtain in measuring the kinetic energy on identically prepared system?

(c)What's the probability of measuring each of these eigenvalues?

(d)What's the average value of $E_{kinetic}$ that you would obtain from a large number of measurements?

(16 %)