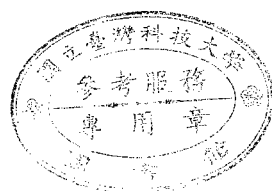


國立台灣科技大學九十七學年度碩士班招生試題

系所組別： 高分子工程系碩士班丁組
 科 目： 物理化學

丁組：物理化學；共 9 大題，總分 100 分；請於答案卷內依序作答

- One mole of an ideal gas with $C_V = 3/2R$ undergoes the transformations described in the following list from an initial state described by $T = 300$ K and $P = 1.00$ bar. Calculate q , w , ΔU , ΔH , and ΔS for each process.
 - The gas is heated to 450 K at a constant external pressure of 1.00 bar.(10%)
 - The gas is heated to 450 K at a constant volume corresponding to the initial volume. (10%)
 - The gas undergoes a reversible isothermal expansion at 300 K until the pressure is half of its initial value.(10%)
- Consider the equilibrium $C_2H_6(g) \rightarrow C_2H_4(g) + H_2(g)$. At 1000 K and a constant total pressure of 1 atm, $C_2H_6(g)$ is introduced into a reaction vessel. At equilibrium, the composition of the mixture in mole percent is $H_2(g)$: 26%, $C_2H_4(g)$: 26%, and $C_2H_6(g)$: 48%.(10%)
 - Calculate K_P at 1000 K.(2%)
 - If $\Delta H_{reaction}^\circ = 137.0$ kJ mol⁻¹, calculate the value of K_P at 298.15 K.(4%)
 - Calculate $\Delta G_{reaction}^\circ$ for this reaction at 298.15 K.(4%)
- At 25°C, the combustion of ethanol in a fix-volume calorimeter produces 1300 kJ/mol of heat. (a) What is ΔU ? (5%) (b) What is ΔH ? (5%)
 *The reaction is $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$
- What are the asymptotic forms of Langmuir adsorption isotherm when the concentration $[A]$ is (a) very low; (b) very high? (4%)
- Complete the following relations: (a) $\left(\frac{\partial T}{\partial V}\right)_S$, (b) $\left(\frac{\partial G}{\partial P}\right)_T$, (c) $\left(\frac{\partial V}{\partial T}\right)_P$ (6%)



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CONSTANTS: $1 \text{ eV} = 1.6\text{E-}9 \text{ J}$
 Planck constant = $6.63\text{E-}34 \text{ J-s}$
 Bohr radius = $5.29\text{E-}11 \text{ m}$
 Mass of electron = $9.11\text{E-}31 \text{ kg}$
 Gas Constant = 8.31J/mole/K

Please indicate clearly units in the answers.

6. (10%) Vibrational levels of lithium bromide molecule (molar mass = 86.8) in its lowest state can be best approximated by a parabolic potential well, and have a force constant equal to 600 eV per square nm..
- 1) Find the characteristic vibrational frequency in the unit of cycle per second. (4%)
 - 2) Find the lowest potential energy of this molecule. (3%)
 - 3) Draw the REAL diagram of potential energy versus internuclear distance between Li and Br for the THREE lowest-value levels. (3%)
7. (10%) The hydrogen-like atom model may be applied approximately to the many-electron atoms. The first ionization energy of helium (atomic number = 2) is 24.6 eV. It is also known that the ionization energy of hydrogen is 13.6 eV.
- 1) Find the effective charge in the nucleus for the outer electron in He. Why is the effective charge lower than the atomic number? (3%)
 - 2) If the wave function for the electron in H is $A \exp(-r/a)$, where A is a constant, r = the distance between the nucleus and the electron, and a = Bohr radius. Please indicate the method and equation to find the atomic radius of He, using this given expression and effective charge concept. (4%)
 - 3) Find the second ionization energy of He. (3%)
8. (10%) Electrons in a transmission electron microscope were accelerated with electric field, and their kinetic energy is 10,000 eV.
- 1) Find the momentum of electrons. (3%)
 - 2) Find the wave length of electron in motion, and compare it with that of x-ray (= 0.154 nm). (4%)
 - 3) If neutrons, used to probe the materials structure, have the same kinetic energy as electron, what is their wave length? (3%)



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9. (10%) At 600 degrees centigrade, copper and gold forms a miscible solid solution.

As the mole fraction of copper equals to 0.6, the activity coefficient of copper and gold is 0.536 and 0.246, respectively.

The saturated vapor pressure (P , in atm) of pure solid copper as a function of temperature (T , in K) is given by

$$\ln P = -40,920/T - 0.86 \ln T + 21.67$$

- 1) Find the partial pressure of copper in the vapor phase in equilibrium with the solid solution at 600 degrees. (3%).
- 2) Find the molar Gibbs free energy of mixing for this solid solution. (4%)
- 3) Find the molar enthalpy of vaporization for the pure copper at 600 degrees. (3%)

