八十四學年度 生物醫學研究 所 組碩士班研究生入學考試

科目 普通化學 科號 1106 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

(1) Calculate the molecular weight of a crystal in which the unit cell is triclinic with cell parameters, a=3.00 Å, b=2.00 Å, c=4.00 Å, α= 90°, β=60°, γ=30°; each unit cell contains 3 molecules and the density is 1.60 g/mL. (10%)

(2) If the reaction of 2 $N_2O_5 \rightleftharpoons 4\ NO_2 + O_2$ follows the mechanism. Please derive the rate law **based on $-d[N_2O_5]/dt$. No credit** will be given if you derive the rate law either from $d[NO_2]/dt$ or from $d[O_2]/dt$. (15 %)

$$N_2O_5 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} NO_2 + NO_3,$$

$$NO_3 + NO_2 \xrightarrow{k_2} NO + NO_2 + O_2,$$

$$NO_3 + NO \xrightarrow{k_3} 2NO_2.$$

(3) One mole of an ideal expands reversibly from a volume of 2 to 20 liters, and the initial and final temperature is kept at 0°C. Calculate the changes of entropy, heat and internal energy of the system. (10 %).

(4) Show clearly the radial probability $4\pi r^2 R^2(r)$ versus r(A) for the following orbitals in the hydrogen atom. (a) 5p (b) 5f (c) 6s. (5 %). [Here R(r) is the radial function and r is the displacement(A) from the nuclei.]

(5) Show the number of unpaired electrons and the splitting of orbital energy of valence electrons for the following compounds (a) C_2 (b) $CoCl_4^{2-}$ (c) $Ni(CN)_4^{2-}$. The atomic numbers of Co and Ni are 27 and 28 respectively. (12 %).

(6) Derive the electron energy of a hydrogen-like atom based on Bohr theory. (13 %).

(7) Calculate $\Delta\mathcal{E}^\circ$ and the equlibrium constant for $2Fe^{3+} + 3I^- = 2Fe^{2+} + I_3^-$. Now $Fe^{3+} + e = Fe^{2+}$ $\Delta\mathcal{E}^\circ = 0.771$ eV, and $2e + I_3^- = 3I^-$, $\Delta\mathcal{E}^\circ = 0.536$ eV. (10 %) (Since no calculator is available, express the equlibrium constant in terms of the value of $\Delta\mathcal{E}^\circ$.

(8) If a reaction has a rate constant $k = 5.03 \times 10^{-2}\ M^{-1}\ sec^{-1}$ at 289° and $k = 6.71\ M^{-1}\ sec^{-1}$ at 333°. Find the activation energy of this reaction. (10 %)

(9) For most solids, the heat capacity C_V is approximately $3R = 6$ cal/mol-deg at high temperatures. Derive this value based on the vibration energy of a solid. (15 %).