國立交通大學 102 學年度碩士班考試入學試題

科目：物理化學(3161)　　考試日期:102 年 2 月 4 日 第 4 節

系所班別：材料科學與工程學系　　組別：材料系乙組　　第 1 頁,共 2 頁

【可使用計算機】＊作答前請先核對試題、答案卷(試卷)與准考證之所組別與考科是否相符！！

1 A redox reaction involving Zn/Zn^{2+} is typically written in $Zn^{2+} + 2e = Zn$, and its standard redox potential is listed at -0.7626 V.

a) What is the value of ΔG (J) for the chemical reaction; $Zn \rightarrow Zn^{2+} + 2e$?

b) What is the equilibrium constant for this redox reaction; $Zn^{2+} + 2e = Zn$?

c) What is the formal potential for this redox reaction assuming the activity coefficient of Zn^{2+} becomes 0.1?

d) Since this redox reaction does not specify the exact solvent in which the Zn^{2+} is dissolved, what do you expect the value of redox potential would be if 0.5 M Zn^{2+} is dissolved in 1 M H_2SO_4 solution and explain your reason?

e) What do you expect the value of redox potential would be if 1 M Zn^{2+} is dissolved in 1 M NH_4OH solution?

(5% in each question)

2 The collision rate (R_{col}) of gas molecules on a solid surface can be expressed by the following equation:

$R_{col} = P/(2\pi mkT)^{1/2}$ (collisions $cm^{-2}\ s^{-1}$),

where m is the molar mass of the gas molecule, T is the absolute temperature, k is the Boltzmann constant (1.38×10^{-23} JK^{-1}), and P is the gas partial pressure (torr = 1 mm Hg). A typical Pt(111) surface has about 10^{15} surface sites per cm^2. If every Pt surface site can accommodate one CO molecule, and half collisions lead to adsorption (sticking probability = 0.5), how long does it take to completely cover a Pt(111) surface with CO molecules when the Pt surface is exposed to CO gas with a partial pressure of 10^{-7} torr? The partial pressures for other impurity gases are assumed to be negligible. (15%)

3 Given the rate constant for the $H + O_2 \rightarrow OH + O$ reaction is 4.7×10^{10} $cm^3mol^{-1}s^{-1}$ at 1000 K and the activation energy is 66.5 kJ/mole, please determine the rate constant at 2000 K. (10%)

4 Scanning tunneling microscopy-Suppose the wave function for the electron in the gap between the sample and tip is given by $\Psi(x)=Be^{-kx}$ where x is the distance between the tip and sample, and $k=(2m_e(V-E)/(h/2\pi)^2)^{1/2}$; take V-E= 6.0 eV. By what factor would the current drop if the probe is moved from 1.0 to 2.0 nm? Note that the probability density is given by $\Psi(x)^2$

$m_e=9.109\times10^{-31}$ Kg; $h=6.626\times10^{-34}$ Js (15%)

5 The potential energy of interaction between two charges q_1 and q_2 separated by a distance r is $V=q_1q_2/4\pi\varepsilon_0 r$, where $\varepsilon_0=8.85\times10^{-12}$ $C^2J^{-1}m^{-1}$ is the vacuum permittivity. To get an idea of the magnitude of forces measured by Atomic Force Microscopy, by what factor does the force drop if the distance between two electrons increases to 2.0 nm from 1.0 nm? $e=1.609\times10^{-19}$ C (Hint: Force=-dV/dr) (10%)

6 The formation enthalpy of the solid solution of NaCl and NaBr at 298°C as a function of the mole fraction X_1 of NaCl is given by
$\Delta H_m(KJ/mol) = 5.231X_1 - 4.466\ X_1^2 - 0.765\ X_1^3$
Please calculate (a) ΔH_m when 0.6 mol NaCl and 0.4 mol NaBr form a solid solution, and (b) the differential heat of solution ΔH_1 and ΔH_2 in the 60/40 mol solid solution. (15%)

7 At P = 1 Kg/cm^2, the molar volume of mercury at 273K is 14.72 cm^3/mol, and the compressibility is $\beta=3.88\times10^{-11}$ m^2/N. Assuming β is constant over the pressure range, please calculate ΔG_m for compression of mercury from 1 to 3001 Kg/cm^2. (10%)