八十五學年度 化學工程學系 系（所） 乙組 組碩士班研究生入學考試

科目 物 理 化 學 科號 1601 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

Problem 1 (20%)

Reported solubility data of nitrogen in liquid ammonia at 0°C are listed as follows:

Pressure(atm)	100	200	400	600
Solubility (c.c. N_2 STP / g NH_3)	7.90	13.73	20.76	24.95

Estimate the solubility of nitrogen in liquid ammonia at 0°C and 1000 atm.

Problem 2 (20%)

A steel casting ($C_p = 0.12(\text{Btu})/(\text{lb}_m)(^\circ\text{F})$) weighing 75 lb_m and having a temperature of 800 °F is quenched in 300 lb_m of oil ($C_p = 0.6\,(\text{Btu})/(\text{lb}_m)(^\circ\text{F})$). If there are no heat losses, what is the change in entropy of (a) the steel casting (b) the oil, and (c) both considered together?

Problem 3 (20%)

(a) (5%) 在微電子工業中常見到"次微米"（submicron），這是指什麼？ 一個μm（micron）相當多少Å，又一個nm（nanometer）相當多少Å？ 是什麼的常用單位？

(b) (5%) 1 gram 重的Si 純度為99.9999999%（Si 的原子序數14原子量為28.09），請指出它的impurities 的原子數目。

(c) (10%) 上述 Silicon 是絕緣体，在微電子工業常用來製作半導体（semiconductor）請說明其製作原理需要 doping 什麼？ 以及電子移動的原理。

Problem 4 (20%)

(i) Compute the standard free energy of disproportionation for the following reactions:

$$2Cu^{+} \longrightarrow Cu^{2+} + Cu$$

$$3Fe^{2+} \longrightarrow 2Fe^{3+} + Fe$$

$$5MnO_4^{2-} + 8H^{+} \longrightarrow 4MnO_4^{-} + Mn^{2+} + 4H_2O$$

(ii) Can you generalize from these results to obtain a criteria for the stability of a species toward disproportionation based on half-cell potentials?

half-cell reaction	E° / v
$MnO_4^- + e^- \longrightarrow MnO_4^{2-}$	0.56
$MnO_4^- + 8H^+ + 5e \longrightarrow Mn^{2+} + 4H_2O$	1.51
$Fe^{3+} + e \longrightarrow Fe^{2+}$	0.771
$Fe^{2+} + 2e \longrightarrow Fe(s)$	-0.44
$Cu^{2+} + e \longrightarrow Cu^+$	0.159
$Cu^{2+} + 2e \longrightarrow Cu(s)$	0.340

Problem 5 (20%)

(a) Please state the Heisenberg Uncertainty principle. Use this principle to calculate the width of the fluorescence line 253.7 nm emitted from mercury vapor with a pulse. The mean life time of the excited state is 2×10^{-8} s. (The speed of light in vacuum is 3×10^8 ms^{-1}.).

(b) Please state the Boltzman distribution law for particles at different energy states. Use this law to calculate the ratio of sodium atoms in the 3P excited states to the number in the ground state (3s) at 2500 and 2510 K. What is the experimental error in the measurement of the number of excited sodium atoms, if the temperature fluctuation is 10 K?

The required data and constants for the calculation are: the average wavelength of the sodium emission line involving the 3p $\longrightarrow$ 3s transition is 5893 $\mathring{A}$; the Planck constant 6.63×10^{-34} Js, the speed of light in vacuum 3×10^8 ms^{-1}, the gas constant 8.314 J $mol^{-1}K^{-1}$ and the Avogardro constant 6.02×10^{23} mol^{-1}.