國　立　清　華　大　學　命　題　紙

九十二學年度＿＿化學＿＿系（所）＿化學、應用化學＿組碩士班研究生招生考試
科目_物理化學及分析化學_科號_0603, 0703_共＿2＿頁第＿1＿頁 *請在試卷【答案卷】內作答

1. List general properties of activity coefficients. (10%)
2. The solubility product of CuI is 1.0×10^{-12}. The formation constant K_2 for the reaction of CuI with I^- to give CuI_2^- is 7.9×10^{-4}. (a) Calculate the molar solubility of CuI in a 1.0×10^{-4} M solution of KI (b) write down the Mass-Balance Equation and Charge-Balance Equation of this system. (15%)

3. For each of the following instrumentations, give **one** suitable sample and describe **one** of the key properties that ensure the measurements, or give **one** inappropriate sample and describe one of the key properties that the sample lacks of.
(For example, IR: H_2O, suitable, strong permanent dipole;
Raman: H_2O, inappropriate, lack of high polarizability.) (10%)
(a) ICP-AES (inductively coupled plasma atomic emission spectroscopy)
(b) ESI-MS (electrospray ionization mass spectroscopy)
(c) GLC (gas-liquid chromatography)
(d) CZE (capillary zone electrophoresis)
(e) STM (scanning tunneling microscopy)

4. In atomic absorption spectroscopy, there are four common methods to correct background absorbance, including two-line, continuum-source, correction based on the Zeeman effect, and correction based on source self-reversal. (10%)
(a) Why background correction in AAS is particularly important?
(b) Explain one of the four correction methods.

5. Among the detector devices of PMT, photodiode array, and thermocouple,
(a) list the order of sensitivity, (5%)
(b) which is/are usually used in multichannel detection,
(c) which is/are usually used in UV spectrometers,
(d) which is/are usually used in AAS,
(e) which is/are usually used in IR spectrometry.

6. Describe the four processes in a Carnot cycle. (4%)

7. After processing one Carnot cycle, what are conserved in the following thermodynamic quantities: internal energy (U), entropy (S), heat and work? (4%)

8. Give the definition for the thermodynamic activity *a* for an ideal gas. (4%)

9. Write the molecular partition function for vibration with one vibrational frequency 4000 cm^{-1} at temperature 298K. You just need to write down the expression. (4%)

10. Sketch the plot for the thermodynamic free energy G for a single component at constant pressure as a function of temperature across two phases. (4%)

11. Give an example to measure the rate constant. Describe the method and display how the rate constant is obtained. (5%)

12. A microscopic particle is confined to move in a one-dimensional box along the x direction. The potential energy is:
$U(x)=0 \quad , \quad 0<x<a$
$U(x)=\infty \ , \ x \geq a$ or $x \leq 0$
(a) Write the Schrödinger equation for the problem, i.e. a particle in a 1-D box. (5%)
(b) Solve the Schrödinger equation to obtain the wave functions for the particle in the box and their corresponding energies. (10%)
(Note: you have to write down your derivation procedures, but you do not need to normalize the wave functions.)

13. Based on your results from the previous problem, sketch qualitative diagrams showing
(a) the wave function with n=2 for a particle in a 1-D box. (5%)
(b) the probability density function with n=2 for a particle in a 1-D box. (5%)