『物理化學』部份　總分 50 分

選擇題: 每題 3 分

1. What are q and ΔS for an isothermal and spontaneous expansion of an ideal gas?
   (a) q=0, ΔS=0　(b) q>0, ΔS=0　(c) q=0, ΔS>0　(d) q>0, ΔS>0　(e) q<0, ΔS=0

2. The coefficient of performance of a refrigerator withdrawing heat from 5 °C to an environment of 35 °C is 9. What is the least work should be supplied to the refrigerator to remove 10 kJ heat inside out?
   (a) 1.1　(b) 0.9　(c) 2.1　(d) 0.1　(e) 0.5 kJ

3. Which one of the following thermodynamic parameters represents the maximum energy that a system can provide for work at constant pressure and constant temperature?
   (a) $\triangle U$　(b) $\triangle H$　(c) $\triangle S$　(d) $\triangle A$　(e) $\triangle G$

4. The de Broglie wavelength of an electron in the electron source of TEM instrument operating at a voltage of 100 KV is about
   (a) 0.4 pm　(b) 4 pm　(c) 40 pm　(d) 4 nm　(e) 40 nm
   (m_e=9.1×10^{-31} kg, e=1.6×10^{-19} C, h=6.6×10^{-34} Js)

5. Among (i) Born-Oppenheimer approximation (ii) Planck distribution (iii) Heisenberg uncertainty principle (iv) Franck-Condon principle, which two use the assumption that the nuclei move relatively slowly than electrons and may be treated as stationary while the electrons move in their field?
   (a) (i, ii)　(b) (i, iii)　(c) (i, iv)　(d) (ii, iii)　(e) (ii, iv)　(f) (iii, iv)

6. Which of the following items is least efficiently heated up by microwave?
   (a) water　(b) glucose　(c) octane　(d) aluminum foil　(e) tristearic acid

7. How many vibrational normal modes does CO_2 have? How many of them are responsible for the green house effect of CO_2?
   (a) (3, 3)　(b) (4, 2)　(c) (3, 2)　(d) (4, 3)　(e) (2, 2)

8. A molecule emits light of 578.1 nm when excited by 532 nm laser and light of 556.9 nm when excited by 514 nm laser. What is this emission called?
   (a) fluorescence　(b) phosphorescence　(c) Rayleigh scattering
   (d) Raman scattering　(e) electroluminescence

9. A nucleus with chemical shift of 1.00 in a NMR spectrometer operating at 100 MHz will have a

frequency shift relative to the reference equal to

(a) 100 Hz　　　(b) 100 KHz　　(c) 100 MHz　　(d) 1100 Hz　　(e) 110 MHz

10. Which is the partition function for a harmonic oscillator with ε as the energy separation of neighboring levels?

(a) $\frac{1}{1+e^{-\beta\varepsilon}}$　　(b) $\frac{1}{1-e^{-\beta\varepsilon}}$　　(c) $\frac{e^{-\beta\varepsilon}}{1+e^{-\beta\varepsilon}}$　　(d) $1 + e^{-\beta\varepsilon}$　　(e) $1 - e^{-\beta\varepsilon}$

11. Which of the following is the closest approximation to the molar heat capacity of water at constant volume and at room temperature?

(a) 12.5　　　(b) 21　　　(c) 25　　　(d) 33　　　(e) 37 JK^{-1} mol^{-1}

12. What is the unit of second order rate constant?

(a) s^{-1}　　(b) s^{-1} M^{-1}　　(c) s^{-1}M　　(d) sM^{-1}　　(e) s.

13. The reactant of a first order reaction takes time τ to decay from $[A]_0$ to $1/64 [A]_0$. What is the half-life of the reactant?

(a) (ln 2)/τ　　(b) ln 2/(8τ)　　(c) 4τ　　(d) τ/2　　(e) τ/6

14. The diffusion coefficient of sucrose in water at 298 K is 0.5×10^{-9} m^{2}s^{-1}. Considering one-dimensional diffusion, how long does it take for sucrose molecules travelling to the root mean square distance of 1 mm?

(a) 10^3 s　　(b) 10^4 s　　(c) 10^5 s　　(d) 10^6 s　　(e) 500 s

論述題：每題4分

1. Construct molecular orbital energy level diagram for O_2 molecule with detailed explanation and write down the term symbol for the ground electronic state of O_2.

2. Explain the photochemical phenomena with the help of Jablonski diagram.

『分析化學』部份　總分 50 分

1. The concentration of one sample is determined with four (4) replicates to obtain average and standard deviation as <x> and s, respectively. When the t-value of degree-of-freedom 3 under y% confidence level is 3, please calculate the difference between the upper and lower limits of the confidence interval of this average value. (5 points)

2. Two mean values A and B are determined with five (5) and three (3) replicates respectively. What is the degree-of-freedom to choose the proper t-value for comparing A and B? (5 points)

3. The first and second stage dissociation constants of diprotic acid H_2A are K_1 and K_2, respectively.
   (1) When K_1 is 1.0×10^{-5} M, please calculate the pH value of H_2A solution of that the volume and concentration are 100 mL and 0.1 M, respectively. (6 points)
   (2) When the solution of (1) is mixed with 10 mL of NaOH (1.0 M), the pH is determined as 7, please estimate the value of pK_2. (6 points)

4. There are two chromatographic peaks of which the base-line widths are both 1 min.
   (1) When the retention times of these two peaks are 8 and 9 min, respectively, please estimate the resolution of these two peaks. (6 points)
   (2) When the capacity factor (k') of the first peak is 2, please estimate the retention time of injection solvent. (6 points)

5. The absorbance of one sample (0.2 M) is measured as 0.1 with a sample cube of which the light path is 1 cm.
   (1) When the other cube with 3-cm light path is used, what is the absorbance value measured with this cube? (6 points)
   (2) If the sample concentration is 0.4 M, what is the absorbance value using the sample cube with 3-cm light path? (6 points)

6. Is SDS-PAGE a suitable technique to separate one native protein and its deamidated form? Why? [Note: SDS-PAGE stands for sodium dodecyl sulfate polyacrylamide gel electrophoresis] (4 points)