1. You want to prepare a liter of an acetate buffer of 0.1 ionic strength and pH 5.0 at 25 degree C. How many moles of sodium acetate and acetic acid should you add if the apparent dissociation constant of acetic acid at this ionic strength is $2.9 \times 10^{-5}$? (7%)

2. One mole of an ideal gas expands from 5 to 1 bar at 298K. Calculate $w$ (a) for a reversible expansion and (b) for an expansion against a constant external pressure of 1 bar ? R = 8.314 $JK^{-1}mol^{-1}$ (10%)

3. Please describe the first, second and third law of thermodynamics. (12%)

4. (a) Please show ( $t_{1/2} = 0.6931/k_1$ ) for a first-order reaction, A ——> B. .
(b) Please show ( $t_{1/2} = 1/k_2[A]_0$ ) for a second-order reaction, A + A -----> B.
ln2 = 0.6931
$k_1$ and $k_2$ are the rate constants of first- and second-order reaction, respectively.
$t_{1/2}$ is the half-life. $[A]_0$ is the initial concentration of reactant A.
Rate law of the first-order reaction is $v = -d[A]/dt = k_1[A]$
Rate law of the second-order reaction is $v = -d[A]/dt = k_2[A]^2$
(14%)

5. (a) Please list the following region of the electromagnetic spectrum from the shortest wavelength to the longest wavelength:
IR, X-rays, Microwaves, UV, Visible, Radio waves
(b) Which one has the highest energy? (7%)

6. 已知：在 25°C 時的形成熱：$H_2O(g)$: -57.8 kcal; $CH_4(g)$: -17.9 kcal
$CH_4(g)$ 在 25°C 時燃燒生成 $CO_2$ 和 $H_2O$ 的燃燒熱等於-192.0 kcal，
求在 25°C 時 $C(s) + 2H_2O(g) = CO_2(g) + 2H_2(g)$的ΔH 與ΔE
(g: gas phase, s: solid phase; $\Delta H = \Delta E + \Delta n_g RT$, $n_g$是氣態物質的莫耳數)(10%)

7. Calculate the reduced mass of an O-H "molecule" and O-D "molecule"
What is the ratio in vibrational frequency between these two?(10%)
($\nu_{vib} = 1/2\pi\sqrt{(k/\mu)}$; where k is the force constant of the bond and μ is the reduced mass of the molecule AB, which is given by $1/\mu = 1/M_A + 1/M_B$, where $M_A$ and $M_B$ are the atomic masses of A and B)

8. If 20.8% of the 340 nm radiation incident on a given solution of NADH is transmitted and if the extinction coefficient of NADH at 340 nm is $6.22 \times 10^6$ $cm^2 \bullet mol^{-1}$, what is the concentration of NADH in the solution? (The path length is 1 cm). (Hint: Beer-Lambert Law: $A = \log_{10}(I_0/I) = \varepsilon cl$, where ε is the extinction coefficient, c is the concentration of the compound, and l is the path length) (10%)

9. Calculate the de Broglie wavelength for a baseball (5 oz) traveling at 90 mph. (Hint: de Broglie wavelength $\lambda = h / mv$, $h = 6.626 \times 10^{-34}$ J•s, 1 lb = 16 oz = 0.454 kg, 1 mile = 1610 meter)(10%)

10. Calculate the de Broglie wavelength of an electron traveling at 1% of the speed of light. (mass of an electron = $9.11 \times 10^{-31}$ kg)(10%)

（請注意：你不能使用任何型式的計算機！如果含有 log 或 ln 等算式無法計算，列出算式即可）。