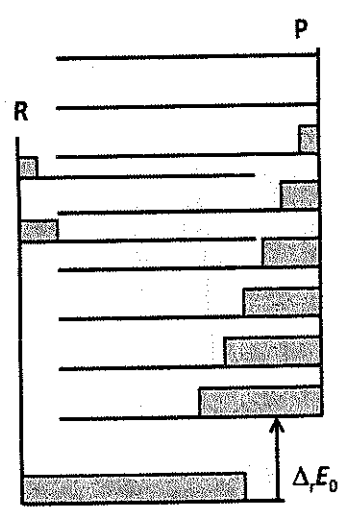
『物理化學』部份　總分50分

1. From the following list of observations, choose the one that most clearly supports the conclusion that electromagnetic radiation has wave characteristics. (5 Pts)

(A) the emission spectrum of hydrogen
(B) the photoelectric effect
(C) the scattering of alpha particles by metal foil
(D) diffraction
(E) cathode "rays"

2. Which side dominate for the reaction $R \rightleftarrows P$ (The Thin bar indicate the energy level and thicker bar indicates the energy distribution) (5 pts)



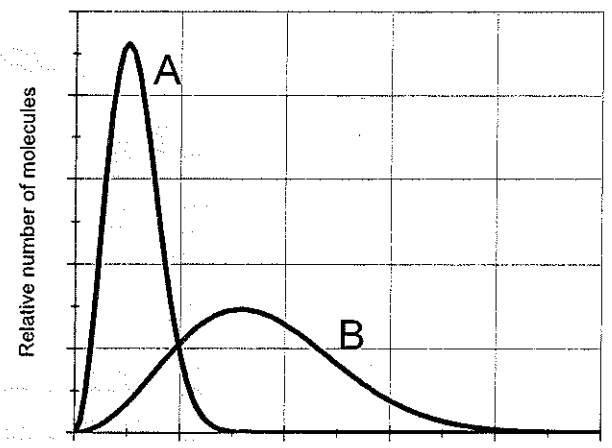
(A) R, due to entropy effect
(B) R, due to enthalpy effect
(C) P, due to entropy effect
(D) P, due to enthalpy effect

3. A turbo pump is comprised of several fans to compress the gas and pump them away from the camber to generate vacuum. The function of fans is compression of the gas by collision between fans and gas molecules. Which molecules are more difficult to be pumped? (5pts)

(A) H_2O
(B) He
(C) N_2
(D) O_2
(E) CO_2

4. The change in the Gibbs energy of a certain constant–pressure process was found to fit the expression $\Delta G/J = -85.40 + 42.8(T/K)$. Calculate the value of ΔS for the process. (5 pts)

5. Consider the following velocity distribution curves A and B



If the plot represent the velocity distribution of 1.0L of He(g) at STP versus 1.0 L of Cl_2 (g) at STP, which plot corresponds to each gas? Explain your reason. (10 pts)

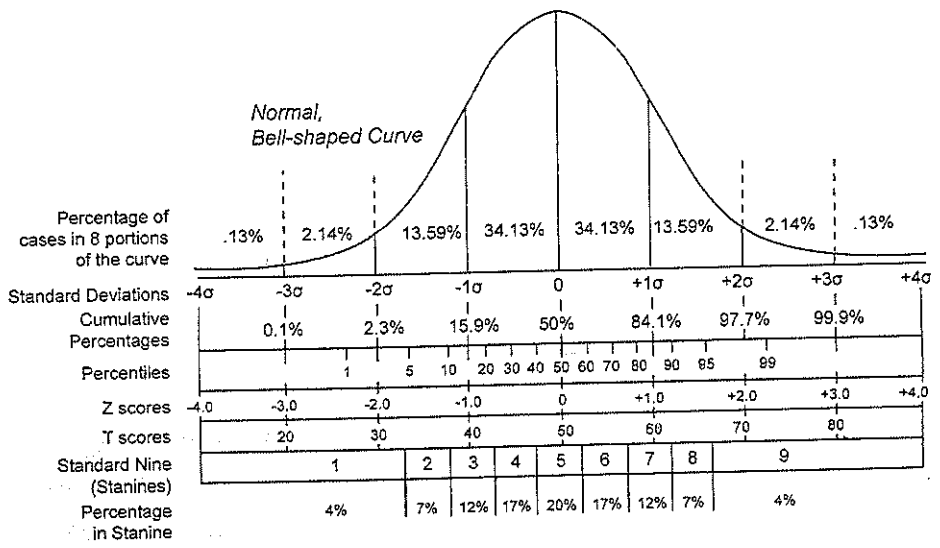
6. Would the following equation of state of a gas, $pV_m = RT(1+b/V_m)$, be possible to liquefy? Explain your answer. (10 pts)

7. Given $[\boldsymbol{A}, \boldsymbol{B}]=0$ and that $\boldsymbol{A}|\varphi\rangle = \alpha|\varphi\rangle$ (i.e. $|\varphi\rangle$ is an eigenket of $\boldsymbol{A}$), please prove by algebra that $|\varphi\rangle$ is also an eigenket of $\boldsymbol{B}$. (10 pts)

『分析化學』部分 總分50分

〔以下每題十分〕

(1) Analysis of a bottle of 100 mg vitamin C tablets yields an average vitamin C content of 99.8 mg, with a standard deviation of 0.3 mg. Assuming Gaussian statistics, how many percentages of the tablets contain between 99.5 and 100.1 mg of vitamin C? [Hint: Use the graph in the below shows the percentage of cases in 8 portions of the Gaussian distribution curve, where 1σ represents one standard deviation.]

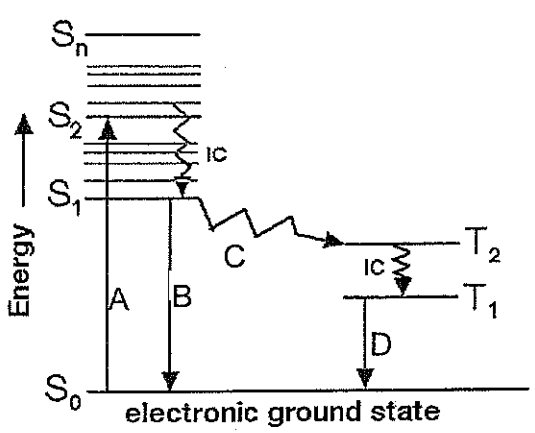


(2) In an experiment to determine fluorescein by fluorescence spectrometry, a series of standards was analyzed and gave a calibration line with a slope 1000 ppb^{-1} and a y-intercept of 35. If a sample gave a fluorescence reading of 850, what is the fluorescein concentration (in ppb) of the sample?

(3) For a diprotic acid H_2A, K_{a1} is 1.0×10^{-2} and K_{a2} is 1.0×10^{-6}. Please prove the pH range in which HA^- is the predominant form is between a pH of 3 and 5.
Hint: the fraction of non-dissociated H_2A in its solution is governed by the following equation, $\alpha_0 = [H^+]^2/([H^+]^2 + K_{a1}[H^+] + K_{a1}K_{a2})$

(4) Using a C8 HPLC column of 5 cm in length, one analyte was eluted at the retention time 2 min, when the mobile phase peak appears at 0.2 min.
I. Please calculate the retention factor (k') of this analyte.
II. Also, estimate the retention factor (k') of this analyte eluted by the same mobile phase solvents when the other C8 column of 10 cm was used.

(5)



In the above energy level diagram showing the processes of fluorescence and phosphorescence, where A represents photon absorption step,

I. Please indicate which other step(s) are needed to complete the processes of fluorescence?

II. What is the step C?