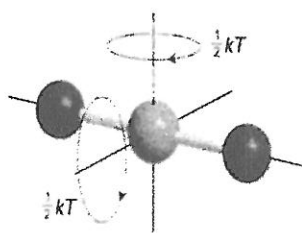
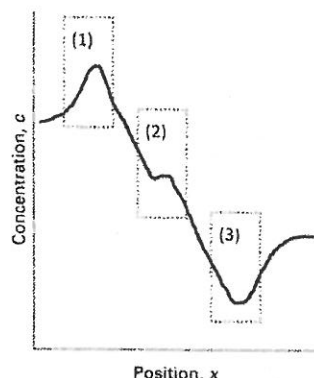


一. 第一部份

- Identify which of the following functions are eigenfunctions of the operator d/dx ? (4%)
 - e^{ikx}
 - $\cos kx$
 - kx
 - e^{-ax^2}
- Which spectrum has the lowest energy gap? (4%)
 - UV
 - IR
 - Microwave
- For calculating enthalpy of formation in a chemical reaction, one can use Hess's law and $\Delta H = \Delta q$ under what kind of condition? (4%)
 - Isotherm
 - Isobars
 - Isochore
- What is the heat capacity of the following linear ideal gas molecule? (R=gas constant) (4%)



- $C_{v,m} = R/2$
 - $C_{v,m} = 3R/2$
 - $C_{v,m} = 5R/2$
 - $C_{v,m} = 3R$
 - $C_{v,m} = 5R$
- The figure shown below shows 1-D diffusion (concentration versus position). Which region show the concentration is increasing with the time? $\frac{\partial c}{\partial t} = D \frac{\partial^2 c}{\partial x^2}$ (4%)



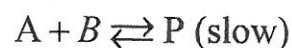
- (a) (1)
- (b) (2)
- (c) (3)
- (d) None of above

6. The ground state wavefunction of a hydrogen atom is

$$\psi = \left(\frac{1}{\pi a_0^3} \right) e^{-r/a_0}$$

where $a_0 = 53$ pm (the Bohr radius). Calculate the probability that the electron will be found somewhere within a small sphere of radius 1.0 pm centred on the nucleus. (10%)

7. The reaction mechanism for the decomposition of A_2



Involves an intermediate A. Deduce the rate law for the reaction by assuming a pre-equilibrium. (10%)

8. A sample consisting of 3.00 mol of diatomic perfect gas molecules at 200 K is compressed reversibly and adiabatically until its temperature reaches 250 K. Given that $C_{v,m} = 27.5 \text{ J K}^{-1} \text{ mol}^{-1}$, calculate

- (1) Internal energy ΔU (5%)
- (2) Entropy ΔS (5%)

二. 第二部份

1. Please estimate the pH value of NaHCO_3 solution (1.0 M, 10 mL) diluted with the following solutions of 100 mL. [答案取至小數點以下一位即可] [10 points]

(1) NaOH solution (0.05 M)

(2) NaCl solution (0.05 M)

[Hint: The dissociation constants of carbonic acid are 5×10^{-7} M and 5×10^{-11} M, respectively.]

2. When $C = A^2 - B^2$, please use ΔA and ΔB , which are the uncertainty values of A and B, to express the error propagation function of ΔC . [8 points]

[Hint: $(\Delta Z)^2 = (\Delta X)^2 + (\Delta Y)^2$ when $Z = X \pm Y$; $(\Delta Z/Z)^2 = (\Delta X/X)^2 + (\Delta Y/Y)^2$ when $Z = XY$.]

3. Please explain why using cyanogen (C_2N_2) flame is able to obtain better signal sensitivity than using acetylene (C_2H_2) flame when carrying out atomic emission spectroscopic analysis? [8 points]

[Hint: The electron population in an excited follows Boltzman distribution. The flame temperatures of acetylene flame and cyanogen flame are 2500 K and 4800 K, respectively.]

4. Two sample peaks of the same half-height width appear in retention times 10 minute and 11 minute, respectively in one HPLC chromatogram.

(1) What is the largest half-height width of each sample peak to remain baseline separation? [5 points]

(2) When the solvent peak appears in 2 minute, what is the capacity factor of the sample peak in 10 minute? [5 points]

5. Please explain why diode laser emitting at 445 nm is NOT an adequate light source to acquire Raman scattering spectrum, but a preferable light source to measure Rayleigh scattering intensity of colloid particles. [5 points]

6. Briefly explain the following terms:

(1) calomel electrode; (2) polarography; (3) Van Deetmer equation [9 points]

