

所別：化學學系碩士班 科目：物理化學與分析化學

1. (10 pts)

(a). Show that If the virial equation of state is truncated as

$$\frac{PV_m}{RT} = 1 + \frac{B_2}{V_m} + \frac{B_3}{V_m^2}$$

A critical point can occur

(b). Find the expression of the critical pressure, critical molar volume, and the critical temperature in terms of the virial coefficients.

(c). Find the value of the corresponding factor $Z = \frac{PV_m}{RT}$ at the critical point.

2. (10 pts) 1.0 mole of carbon dioxide I expanded adiabatically and reversibly from 298.15 K and a molar volume of 5.00 L to a volume of 20.0L

(a) Find the final temperature, assume the gas to be ideal with

$$C_v = 5R/2 = \text{constant}$$

(b) Find the final temperature, assuming the gas to be described by the van der Waals equation with $C_v = 5R/2 = \text{constant}$.

3. (10 pts) A series of line of H atom is observed at 656.46 nm, 486.27 nm, 410.29 nm. What is the next wavelength observed in this series? What is the lower state principle quantum number, n? What is the ionization energy of the atom when it is in the lower state of the transition (i.e. quantum number = n)? (Rydberg Constant = $1.097 \times 10^7 \text{ cm}^{-1}$)

4. (20 pts) In general the time dependent Schrodinger equation for a time dependent Hamiltonian is $H\Psi = i\hbar \frac{d\Psi}{dt}$ where $H = K(\text{kinetic energy}) + V$

(Potential Energy) and $\Psi(x,t)$ is the wave function. (a) Assume $V(x)$ is

independent of time, show that the Hamiltonian can be reduced to two equations, one being time dependent, and another spatial dependent. (b)

What is the expression of the time dependent wave function? Suppose the wave function solved from the spatial dependent Schrodinger equation is

$\phi(x)$ (c) what is the total wave function? (d) Show that the probability of the

particle occurring in space is independent of time.

注意：背面有試題

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5. Define following term: (total 20 pts, each 4 pts)
- (a) Back titration, (b) Systematic error and Random error,
 - (c) Overpotential, (d) Solid-phase microextraction (SPME),
 - (e) Enzyme-linked immunosorbent assay (ELISA).
6. Describe the elution process of the reversed-phase and normal-phase HPLC (high-performance liquid chromatography) according to the polarity of analytes and their elution times. (10 pts)
7. The diprotic acid H_2A has $pK_1 = 4.00$ and $pK_2 = 8.00$.
- (a) At what pH is $[H_2A] = [HA^-]$?
 - (b) At what pH is $[HA^-] = [A^{2-}]$?
 - (c) Which is the principal species at pH 2.00?
 - (d) Which is the principal species at pH 6.00?
 - (e) Which is the principal species at pH 10.00? (10 pts)
8. State the advantages and disadvantages of a furnace compared with a flame in atomic absorption spectroscopy. (10 pts)