淡江大學八十七學年度碩士班入學考試試題

系別： 化學系　　科目： 物理化學

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1) According to the kinetic theory of gases we could establish the relationship between the average kinetic energy ($mv^2/2$) of ideal gases and the corresponding temperature (T) as follows:

$$mv^2/2 = (3/2)(R/Na)=(3/2)k_bT$$

in which m is the mass of a particle, v is it's speed, R is the gas constant, N_A is the Avogadro's number and k_b is Boltzmann's constant. Please derive this relationship based on the assumptions you introduce.

2) Based on the phase diagram of water (Fig. 1) please identify the following physical quantities and their reasonings.

a) normal boiling point
b) normal melting point
c) triple point
d) Vapor pressure (at normal boiling point)
e) condensation
f) fusion

3) Please use very simple model to describe the electron transfer in $[H_2\text{-}H_2]^+$, i.e. how electron will transfer from H_2 to H_2^+ to give rise to H_2^+ and H_2 within $[H_2\text{-}H_2]^+$, then elaborate the factors governing the rate of electron transfer based on your simple model

4) Please illustrate the relationship between particle-wave duality of electron and normalization constraint, then explain why the Schrödinger equation indeed provides a comprehensive tool to study the behavior of electron.

5) Please define what the spectroscopy really is, then try to explain how the resonance condition, i.e. $\Delta E = h\nu$ in which h is Planck constant and ν is light frequency, can be related to the spectroscopic measurement, finally illustrate the relationship between the uncertainty principle, i.e. $\Delta E * \Delta t \geq \hbar /2$, the

spectroscopic measurement.

6) According the free-electron model of solid in one-dimension the Schrödinger equation can be written as

$$\frac{-\hbar^2}{2m_e}\frac{d^2}{dx^2}\Psi(x) = \varepsilon\Psi(x)$$

with the periodic boundary condition

$$\Psi(0) = \Psi(L)$$

in which the L is the length of solid in one-dimension. Firstly please show that the following equations satisfy the Schrödinger equation and boundary condition above.

$$\Psi(x) = e^{ikx}$$

$$k^2 = \frac{2m_e\varepsilon}{\hbar^2}$$

$$k = \frac{2\pi n}{L} \quad n = 0,\ \pm 1,\ \pm 2, \ldots..$$

Secondly please demonstrate that there is a two-fold orbital degeneracy. Finally please draw the $\Psi(x)$ using $k = 0$ and π to illustrate the behavior of free electron within the solid in one dimension.

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Fig. 1