說明: 1. 請依序作答並標明題號
2. 計算題必須寫出計算過程,只寫答案不給分
3. R=8.31 J/K mol

1) Explain the following terms: (20%)
(a) intensive property (b) tunnelling effect (c) Joule-Thomson effect
(d) heat (e) first order phase transition (f) triple point
(g) Heisenberg uncertainty principle (h) phase rule
(i) standard states of real gases (j) colligative property

2) Give van der Waals equation and explain it. (5%)

3) What kinds of energies should be included in internal energy? (5%)

4) Justify that the change in enthalpy is equal to the heat supplied at constant pressure to a system. (5%)

5) Helmholtz energy A=U-TS is sometimes called "the maximum work function". Explain it (hint: using Clausius inequality $dS \geq dq/T$). (8%)

6) Calculate the entropy change of a sample of n mole perfect gas when it expands isothermally and reversibly from a volume V_i to a volume V_f. (5%)

7) (a) Write down the Schrödinger equation for a particle with a mass of m moving in a potential well of V (2%) (b) What is the wavefunction for the particle at V=0. (2%)

8) The vapor pressure of ketone carvone (M=150.2 g/mol), a component of oil of spearmint, is as follows:

θ/°C	57.4	100.4	133.0	157.3	203.5	227.5
p/Torr	1.00	10.0	40.0	100	400	760

What are (a) the normal boiling point (2%) and (b) the enthalpy of vaporization of carvon? (6%)

(背面仍有題目,請繼續作答)

9) The standard Gibbs energy of reaction for the decomposition
$H_2O(g) \text{----> } H_2(g) + 1/2\ O_2(g)$
is 118.08 kJ/mol at 2300 K.
(a) What is the equilibrium constant (5%)
(b) what is the degree of dissociation of H_2O at 2300 K and 1 bar (the degree of the dissociation of H_2O is small). (5%)

10) Describe the process of phosphorescence. (5%)

11) Using steady-state approximation to derive the rate law for the decomposition of N_2O_5, $2\ N_2O_5(g) \text{---> } 4\ NO_2(g) + O_2(g)$ on the basis of the following mechanism 10(%)

$N_2O_5 \text{ ---> } NO_2 + NO_3$ k_a
$NO_2 + NO_3 \text{ ---> } N_2O_5$ k'_a
$NO_2 + NO_3 \text{ ----> } NO_2 + O_2 + NO$ k_b
$NO + N_2O_5 \text{ ----> } 3\ NO_2$ k_c

12) Give energy expressions for the vibrational and rotational motions of a diatomic molecule and for the P, Q, and R branches. (10%)

13) $\Omega\psi_1=\omega_1\psi_1$, $\Omega\psi_2=\omega_2\psi_2$. What is the expectation value of Ω for $C_1\psi_1+C_2\psi_2$ (ψ_1, ψ_2 are normalized and they are orthogonal) (5%)