國立成功大學

112學年度碩士班招生考試試題

編　號：75

系　所：化學工程學系

科　目：化工熱力學

日　期：0206

節　次：第 2 節

備　註：可使用計算機

編號： 75

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※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. **(8%)**

For a liquid (molecular weight = 146 g/mole) the isothermal compressibility ($\kappa \equiv \frac{1}{V}(\frac{\partial V}{\partial P})_T$) can be expressed as $\kappa = \frac{a}{V(P+b)}$ here a and b are functions of temperature only. If 100 g of liquid is compressed isothermally and reversibly from 1 to 250 bar at 127°C, how much work is required? At 127°C, a = 0.24 cm^3/mole and b = 210 bar.

2. **(8%)**

One mole of an ideal gas with constant heat capacity undergoes a reversible process, ΔU can be expressed as $a\Delta(PV)$ and ΔH can be expressed as $b\Delta(PV)$. For $C_p = \frac{5R}{2}$, what are the values of a and b?

3. **(17%)**

A reversible compression of n mol of an ideal gas in a piston/cylinder device resulting in a pressure increase from 1 bar to 8.5 bar and a temperature increase from 300 K to T_2. The path followed by the gas during compression is given by $PV^k = PV^{1.33} = constant$. And the molar heat capacity of the gas is given by

$$\frac{C_p}{R} = 3.5 + 0.6 \times 10^{-3}\ T \quad (T = K).$$

(1) Determine the final temperature. **(4%)**

(2) Develop an equation for heat transferred (Q) as a function of C_p, k, R, T. **(9%)**

(3) Determine the heat transferred (Q) during this process. **(4%)**

4. **(18%)**

Given $d\left(\frac{nG^R}{RT}\right) = \frac{nV^R}{RT}dP - \frac{nH^R}{RT^2}dT + \sum_i \frac{\overline{G}_i^R}{RT}dn_i$ Please write down the Maxwell relations. **(15%)**

Also, write down the equation for $\frac{\overline{G}_i^R}{RT}$ in terms of fugacity coefficient. **(3%)**

[Note] Things you must pay attention to:

(1) there would be no mole numbers, n, appear;

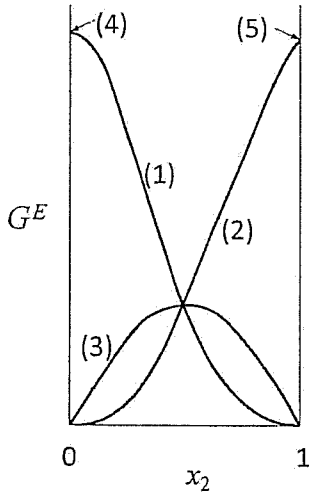
(2) you must state the subscripts, i.e., what conditions should be kept constant;

(3) should there be any expression appear to be in the form fitted with definition of partial molar property, you would have to turn it into the notation of partial molar properties.

5. **(16%)**

There are two species, 1 and 2, in the mixture solution at constant T and P. The molar fractions are notated as x_1 and x_2.

The profiles in the figure indicated as (1),(2), (3) are $\overline{G}_2^E$, $\overline{G}_1^E$, G^E.



(1) Please indicate what are point (4) and point (5). **(4%)**

(2) Please derive by using equations to calculate and obtain the expressions of $\overline{G}_1^E$ and $\overline{G}_2^E$. **(12%)**

[Note] The expressions must contain $\frac{dG^E}{dx_2}$

6. **(15%)**

Consider an irreversible adiabatic process in a closed system, in which 1 mol of fluid expands from an initial equilibrium state A to a final equilibrium state B. If the total change of entropy of the system and surroundings as a result of this process is ΔS_{total}, what are the sign and the magnitude of ΔS_{total}? Explicitly, please answer if $\Delta S_{total} \leq 0$, $\Delta S_{total} < 0$, $\Delta S_{total} = 0$, $\Delta S_{total} > 0$, or $\Delta S_{total} \geq 0$.

Please provide your rationale clearly, preferably in mathematics description, leading to your answer.

7. **(18%)**

Consider an isothermal expansion process. What is the change of the internal energy per mol of fluid, if

(1) an ideal gas is expanded isothermally from the initial volume V to $10V$? **(5%)**

(2) a Redlich-Kwong fluid undergoes isothermally from a state near a liquid, i.e. under very high pressure, to a state near an ideal gas? **(13%)**

The Redlich-Kwong fluid follows $P = \frac{RT}{V-b} - \frac{a}{\sqrt{T}\cdot V(V+b)}$, where P is the pressure, R the gas constant, T the temperature, V the molar volume, a the constant correcting for attractive potential of molecules, and b the constant correcting for volume.