※ 考生請注意：本試題 ☑可　□不可　使用計算機

This examination paper contains EIGHT questions and comprises TWO printed pages.

(Question 1)

A stream of propane gas at 500K and 36 bar expands isentropically in a turbine to 2 bar. If the properties of propane can be described by equations for an ideal gas, please determine

(1) the temperature of the expanded gas, and　　　　　　　　**[10 %]**

(2) the maximum work could be obtained from this turbine.　　**[12 %]**

The constant-pressure heat capacity of the propane gas, C_P, could be expressed as

$\dfrac{C_P}{R} = 1.213 + 0.028785 \cdot T - 8.824 \times 10^{-6} \cdot T^2$, where R and T are the universal gas constant and the absolute temperature in the Kelvin scale, respectively. Please give all assumptions you have made leading to your answer. (R = 8.314 J·/mol^{-1}·K^{-1})

(Question 2)

The vapor-phase molar volume of a particular compound is reported at 22.6 L/mol at 300K and 1 atm. The intermolecular forces in the vapor phase of this compound are not strong, but still never negligible. No other data are available. Please give a reasonable estimate of the molar volume of this vapor at 300K and 4 atm, without assuming ideal-gas behavior.

[Universal gas constant: $R=0.08206$ (atm·L)/(mol·K)]　　　　**[12 %]**

(Question 3)

Water flows in a pipe at 3 m/s. A valve at the end of the pipe is suddenly closed. Then, the pressure in the pipe is dropped or increased? Please give your comment. **[6%]**

(Question 4)

(a) What is the major feature of a Rankine cycle?　　　**[4%]**

(b) Please draw a TS diagram of this Rankine cycle.　　**[4%]**

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(Question 5)

(a) What is the result of the energy conservation from thermodynamic first law for a throttling process?　　**[5%]**

(b) List one device in unit operation similar to the throttling process that ever recalled to you. **[4%]**

(Question 6)

An inventor claims to have devised a cyclic engine which exchanges heat with reservoirs at 25 °C and 250 °C, and which produces 0.45 kJ of work for each kJ of heat extracted from the hot reservoir. Is the claim believable? Please give your comment.　　**[10%]**

(Question 7)

Consider a binary aqueous solution. Let x_1 and x_2 be the respective mole fractions of component 1 and 2. At constant temperature and pressure, the activity coefficient for component 1 is given in the following form:

$$\gamma_1 = \exp\left(Ax_2^2 + Bx_2^3\right),$$

where A and B are constants.

(a) Find the corresponding activity coefficient for component 2.　　**[8%]**

(b) Find the expression of the molar excess free energy G^E in terms of x_i for this solution.　**[9%]**

(Question 8)

A binary system of components 1 and 2 consists of vapor and liquid phases in equilibrium at temperature T=343.15K. The activity coefficients for these components are given by

$$\ln\left(\gamma_1\right) = x_2^2 \text{ and } \ln\left(\gamma_2\right) = x_1^2,$$

where x_1 and x_2 are the mole fractions of component 1 and 2 in the liquid phase, respectively. The corresponding saturated pressures are $P_1^{sat} = 80$ kPa and $P_2^{sat} = 40$ kPa. At $x_1 = 0.6$, please answer the following questions. Assume that the vapor phase is ideal.

(a) Find the bubble pressure P.　　　　　　　**[8%]**

(b) Determine the vapor composition.　　　　　**[8%]**

END OF PAPER.