系所組別： 航空太空工程學系甲、丁組

考試科目： 熱力學

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

1.Please answer the following questions :(20 分)

(a) What are the internal energy, total energy, enthalpy, entropy and exergy related to a system?

(b) Please compare the work done in an expansion process from P_1 to P_2 for the isentropic, isothermal, isobaric and polytropic processes.

(c) When two fluid streams are mixed in a mixing chamber, can the mixture temperature be lower than the temperature of both streams? Why?

(d)It is well known that the thermal efficiency of heat engine increases as the temperature of the energy source increases. In an attempt to improve the efficiency of a power plant, somebody suggests transferring heat from the available energy source to a higher temperature medium by a heat pump before energy is supplied to the power plant. What do you think of this suggestion? Why?

2. Consider a well-insulated horizontal rigid cylinder that is divided into two compartments. Initially one side of the piston contains $1.5m^3$ of air at 600 kPa and 100°C while the other side contains $5m^3$ of air at 400kPa and 20°C while the piston is locked by a pin. The piston is then released and is free to move. Thermal equilibrium is finally established in the cylinder as a result of heat transfer through the piston. Assume that the thermal process is much slower than the mechanical process, determine the final equilibrium temperature in the cylinder. (20 分)

3. Answer the following true or false. If false, explain why (答"true"不用解釋，答"false"一定要解釋正確說法，沒有解釋不給分；答錯倒扣一半分數,請勿猜寫!!) (20%)

(1) According to Clausius Statement of the second law of the thermodynamics, if a room is heated using a heat pump the heat input to room is always greater than the work input to the heat pump. Therefore it violates the first law of thermodynamics.

(2) When a closed system is undergoing a process, the entropy of the system is always increased.

(3) According to the second law of thermodynamics, for a closed system performing a cycle, the cycle integration of the work (input and output) will not always equal to the cycle integration of the heat (input and output).

(4) The above statement in (3) violates the first law of thermodynamics.

(背面仍有題目,請繼續作答)

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(5) A gas contained within a piston-cylinder assembly expands adiabatically. The gas is subsequently compressed back to its initial state. The gas undergoes a reversible process.

4. (20%) An ideal gas in a closed system undergoes a cycle composed of the following three internally reversible processes:

Process 1-2: a constant-pressure expansion at 300 kPa from 20 to 160 ℃,
Process 2-3: a constant-volume cooling to 20 ℃, and
Process 3-1: an isothermal compression to 300 kPa.

Let c_v=3.12 kJ/(kg-K) and R= 2.08 kJ/(kg-K) for this gas. Determine

(a) the heat transfer for each process, in kJ/kg, and

(b) the thermal efficiency of the cycle.

5. (20%) When a fluid expands through a porous plug (or a valve) to a lower pressure is called a throttling process, which is commonly used to determine the Joule-Thomson coefficient

$$\mu_J \equiv \left(\frac{\partial T}{\partial p}\right)_h,$$

since the enthalpy of the fluid remains approximately constant during such a process.

(a). Show that μ_J is related to the constant pressure specific heat c_p

$$\mu_J = -\frac{1}{c_p}\left[v - T\left(\frac{\partial v}{\partial T}\right)_p\right].$$

(b). For a gas obeying the equation of state $p(v-b) = RT$, where b is a positive constant, can the temperature be reduced in a Joule-Thomson expansion?

(c). Can a throttling process be used to lower the temperature of an ideal gas? Why?

(d). The throttling process, like free expansion, is irreversible, please find the entropy production in terms of pressure drop Δp.