所別： 能源工程研究所 碩士班 不分組(一般生)　　　　　　共 1 頁　第 1 頁

科目： 基礎熱力學

本科考試可使用計算器，廠牌、功能不拘　　　　　　　＊請在答案卷(卡)內作答

請按題號順序作答，避免被漏改。若您要先做後面題目，請先在答案本預留空間。

1. (25 %) A piston–cylinder device with a set of stops initially contains 0.5 kg of steam at 1.0 MPa and 600°C. The specific volume is 0.401 m³/kg at the initial state. The location of the stops corresponds to 60 percent of the initial volume. The steam is then cooled to reach the final pressure of 500 kPa.

   (Some properties of steam: At 1.0 MPa, the saturated temperature is 180°C. At 500 kPa, the saturated temperature is 152°C, the specific volume of saturated liquid is 0.001 m³/kg, and the specific volume of saturated vapor is 0.375 m³/kg)

   (5%) (a) Determine the phase condition of the steam at the initial state. (i.e. compressed liquid, saturated liquid, saturated vapor, saturated mixture, or superheated vapor.)
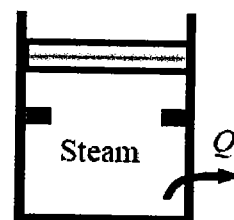
   (5%) (b) Determine the phase condition of the steam at the final state.

   (5%) (c) Can you determin the temperature at the final state? Why?

   (5%) (d) Determine the boundary work during the process.

   (5%) (e) Show the process path and its direction in the P-v property diagram.
   　　　(P is the pressure and v is the specific volume.)

2. (15 %) Peter claimed that he has invented a machine that can steadily covert 100 kW thermal energy to 80 kW work. The heat source is maintained at 450 K and the environment is maintained at 300 K during operation.

   (5%) (a) Does the machine violate the first law of thermodynamics? Please briefly explain.

   (5%) (b) Determine the thermal efficiency of the machine.

   (5%) (c) Is Peter's claim reasonable? Please briefly explain.

3. (10 %) In a power plant, a pump is used to raise steam (water) pressure from P_1 to P_2 steadily. The enthalpy at the initial and final states are h_1 and h_2, respectively. The inlet and exit velocities are V_1 and V_2, respectively. The mass flow rate of the steam is $\dot{m}$. Assume the process is steady and adiabatic, and the potential energy is negligible. Perform the energy balance analysis and express the power input of the pump ($\dot{W}$) in terms of the given properties and conditions.

4. (10 %) The *Clapeyron equation* is expressed as
$$\left(\frac{dP}{dT}\right)_{sat} = \frac{s_{fg}}{v_{fg}} = \frac{h_{fg}}{Tv_{fg}}$$
How can we utilize this equation?

5. (20 %) 家用冰箱只有一個壓縮機，卻可以製造出冷凍室、冷藏室等兩個以上不同溫度的空間，請說明其原理。

6. (20 %) An ideal gas Carnot cycle uses helium as the working fluid and rejects heat to a lake at 10°C. Determine the pressure ratio, compression ratio, and minimum temperature of the heat source for this cycle to have a thermal efficiency of 60 percent.