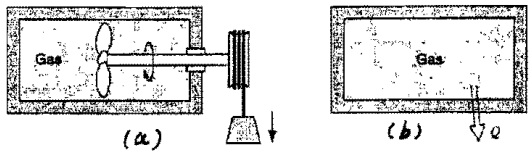
※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

1. Describe physically a constant-pressure process from liquid to vapor phase using a piston/cylinder arrangement for water. Draw qualitatively two different constant-pressure processes in a T (temperature)-v (volume) diagram ($P_1 > P_2$). 10%

2. State the two processes (a & b) for the control mass undergoing a cycle given below, and then state the first law of thermodynamics for this system. 9%



3. What is the "internal energy" of the mass? Why tables of thermodynamic properties contain the "internal energy" not the "energy"? Hint: A correct answer to the 2nd question serves to be part of the right answer to the 1st question. 9%

4. Give definitions of heat engines and heat pumps. Why do we define them? 14%

5. What is the thermodynamic property derived from the 2nd Law of thermodynamics? Derive it. 10%

6. The shaft work in a pump to increase the pressure is small compared to the shaft work in an air compressor for the same pressure increase. Why? 6%

7. A piston/cylinder assembly in a car contains 0.2 L of air at 90 kPa and $20°C$. The air is compressed in a quasi-equilibrium polytropic process with polytropic exponent $n = 1.25$ to a final volume six times smaller $R = 0.287 \frac{kJ}{kg - K}$.
Determine the final pressure, temperature, and the work for the process.
How is the heat transfer be calculated in this process? 14%

(背面仍有題目,請繼續作答)

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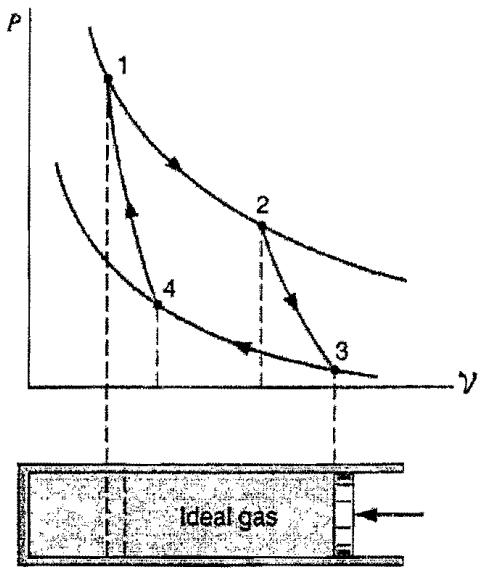
8. Air in a piston/cylinder setup goes through a Carnot cycle with the P-v diagram shown below. The high and low temperatures are 600 K and 300 K, respectively. The heat added at the high temperature is 250 kJ/kg, and the lowest pressure in the cycle is 75 kpa. $R = 0.287\frac{kJ}{kg-K}$. Find the specific volume and pressure after heat rejection and the net work per unit mass. 14%



9. A cylinder/piston setup contains 1 L of saturated liquid refrigerant R-12 at $20^{\circ}C$ (state 1). The piston now slowly expands, maintaining constant temperature to a final pressure of 400 kPa (state 2) in a reversible process. Calculate the required work and heat transfer to accomplish this process. Given $P_1 = 567.3$ kPa

$v_1 = 0.000752\frac{m^3}{kg}$, $h_1 = 54.87\frac{kJ}{kg}$, $s_1 = 0.2078\frac{kJ}{kg-K}$, $v_2 = 0.04584\frac{m^3}{kg}$,

$h_2 = 198.91\frac{kJ}{kg}$, $s_2 = 0.7204\frac{kJ}{kg-K}$ 14%