所別：機械工程學系碩士班 丙組(熱流) 科目：熱力學
生物醫學工程研究所碩士班
能源工程研究所碩士班

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。
選擇題為單選或複選請自行判斷，必須全部答對才給分。

1. (15 %) A piston-cylinder device is initially filled with helium gas at 150 kPa, 20°C, and 0.6 m^3. The helium is compressed polytropically (PV^n = constant) to 400 kPa and 140°C. Helium is an ideal gas with constant specific heat (C_v = 3.1156 kJ/kg·K) and the gas constant is R = 2.0769 kPa m^3/kg·K. Make the necessary assumptions and determine the work and heat transfer during this process.
2. (10 %) Describe the characteristics of all heat engines. If you are a thermal engineering, can you design a heat engine that has a thermal efficiency of 100 percent? Explain the theoretical background of your answer.

3. (10 %) A 0.5-m^3 rigid tank contains hydrogen at 20°C and 900 kPa and another 0.5-m^3 rigid tank holds hydrogen at 30°C and 300 kPa. Two rigid tanks are connected to each other by a valve. Now the valve is opened and the system is allowed to reach thermal equilibrium with the surroundings, which are at 10 °C. The gas constant is R = 4.124 kPa m^3/kgK. Find the final pressure in the tank.

4. (12 %) Briefly explain what is the second law of thermodynamics and its usage in thermodynamics?

5. Describe the difference between the refrigeration cycle and the heat pump cycle in terms of
   (a) Purpose and the corresponding working mechanism. (6%)
   (b) The coefficient of performance (COP). (6%)

6. (5 %) A unit mass of an ideal gas at temperature T undergoes a reversible isothermal process from pressure P_1 to pressure P_2 while losing heat to the surroundings at temperature T in the amount of q. If the gas constant is R, the entropy change of the mass during this process is
   (a) $\Delta s = R\ln(P_2/P_1)$ (b) $\Delta s = R\ln(P_2/P_1) - q/T$ (c) $\Delta s = 0$ (d) $\Delta s = R\ln(P_1/P_2)$ (e) $\Delta s = R\ln(P_1/P_2) - q/T$

7. (6%) Which statements below violate the second law of thermodynamics?
   (a) A heat engine cannot have a thermal efficiency of 100%.
   (b) For all reversible processes, the second-law efficiency is 100%.
   (c) The second-law efficiency of a heat engine can be greater than its thermal efficiency.
   (d) The second-law efficiency of a process is 100% if no entropy is generated during that process.
   (e) The COP of a refrigerator always small than 1.

8. (10%) An ideal gas refrigeration cycle using air as the working fluid operates between the pressure limits of 80 kPa and 240 kPa. Air is cooled to 40 °C before entering the turbine. Assuming constant properties, what is the lowest temperature of this cycle?

9. (5%) A substance whose Joule-Thomson coefficient is positive is throttled to a lower pressure. During this process, (select the correct statements)
   (a) the temperature of the substance will increase.
   (b) the temperature of the substance will decrease.
   (c) the entropy of the substance will remain constant.
   (d) the entropy of the substance will decrease.
   (e) the enthalpy of the substance will decrease.

注意：背面有試題

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10. (5%) Air in a space heating system is heated while being humidified by steam injection. On the psychrometric chart, this process will appear as a line that is
(a) horizontal to the right,
(b) vertical upward,
(c) diagonal upwards to the right (NE direction)
(d) diagonal upwards to the left (NW direction)
(e) diagonal downwards to the right (SE direction)

11. (5%) Propane C_3H_8 is burned with 120 percent theoretical air. What is the air-fuel mass ratio for this combustion process?

12. (5%) Of the reactions given below, the reaction whose equilibrium composition at a specified temperature is not affected by pressure is
(a) $S + O_2 \rightarrow SO_2$
(b) $CO + \frac{1}{2}O_2 \rightarrow CO_2$
(c) $H_2 + O_2 \rightarrow 2HO$
(d) $H_2 \rightarrow 2H$
(e) all of the above.