國立臺北科技大學

九十九學年度研究所碩士在職專班入學考試

能源與冷凍空調工程系碩士班

丙組：熱力學試題

填准考證號碼

注意事項：

1. 本試題共【五】題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在試卷答案欄內，否則不予計分。

1. **(20%)** A piston-cylinder device (**Fig. P1**) initially contains 0.5 m^3 of nitrogen gas at 400 kPa and 27℃. An electric heater within the device is turned on and is allowed to pass a current of 2A for 5 min from a 120-V source. Nitrogen expands at constant pressure, and a heat loss of 2800 J occurs during the process. Determine the final temperature of nitrogen. (The specific heat of nitrogen is c_p= 1.039 kJ/kgK)

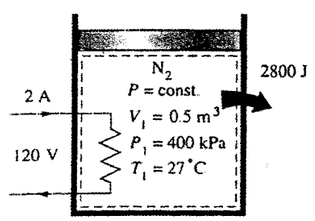

Fig. P1

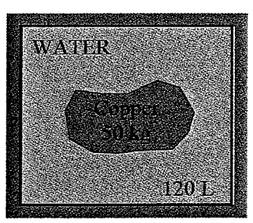

Fig. P2

2. **(20%)** A 50-kg copper block (**Fig. P2**) initially at 80℃ is dropped into an insulated tank that contains 120 L of water at 25℃. Determine the final equilibrium temperature and the total entropy change for this process. ($c_{p,\ water}$= 4.18 kJ/kgK, $c_{p,copper}$= 0.386 kJ/kgK)

3. **(20%)** A well-insulated, shell-and-tube heat exchanger (**Fig. P3**) is used to heat water (c_p=4.18 kJ/kgK) in the tubes from 20 to 70℃ at a rate of 4.5 kg/s. Heat is supplied by hot oil (c_p= 2.30 kJ/kgK) that enters the shell side at 170℃ at a rate of 10 kg/s. Disregarding any heat loss from the heat exchanger, determine (a) the exit temperature of the oil and (b) the rate of entropy generation in the heat exchanger.

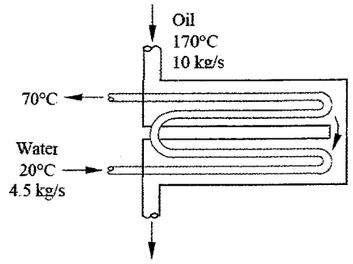

Fig. P3

4. **(20%)** A Carnot heat engine receives heat from a reservoir at 900℃ at a rate of 800 kJ/min and rejects the waste heat to the ambient air at 27℃. The entire work output of the heat engine is used to drive a refrigerator that removes heat from the refrigerated space at -5℃ and transfers it to the same ambient air at 27℃. Determine (a) the maximum rate of heat removal from the refrigerated space and (b) the total rate of heat rejection to the ambient air.

5. **(20%)** A 0.25-m^3 insulated piston-cylinder device (**Fig. P5**) initially contains 0.7 kg of air at 20℃. At this state, the piston is free to move. Now air at 500 kPa and 70℃ is allowed to enter the cylinder from a supply line until the volume increases by 50 percent. Using constant specific heats at room temperature, determine (a) the final temperature, (b) the amount of mass that has entered, and (c) the work done. (The gas constant of air is R = 0.287 kJ/kg.K and the specific heats of air at room temperature are cp = 1.005 kJ/kg.K, cv = 0.718 kJ/kg.K).

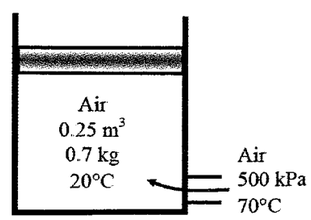

Fig. P5