※ 考生請注意：本試題 ☑可 □不可 使用計算機

(1) Answer the following questions. (20%)

(a) What is the difference between a refrigerator and a heat pump?

(b) Prove that a cyclic device that violates the Kelvin-Planck statement of the second law also violates the Clausius statement of the second law.

(2) In an air-standard Brayton cycle the air enters the compressor at 0.1 MPa, 15 °C. The pressure leaving the compressor is 1.0 MPa, and the maximum temperature in the cycle is 1100 °C. (30%)

(a) Show the P-v and T-s diagram.

(b) Determine the pressure and temperature at each point in the cycle.

(c) Determine the compressor work, turbine work, and cycle efficiency.

(3) An insulated, rigid tank contains 4Kg of air at 450 KPa and 30 °C. A valve is now opened and air is allowed to escape until the pressure inside drops to 150KPa. Assuming that the air inside the tank has undergone a reversible, adiabatic process, please determine the final mass and the final temperature in the tank. (20%)

(4) Prove the statements below. (30%)

(a) Show that the Joule-Thomson coefficient of an ideal gas is zero.

(b) Develop an expression for the change in internal energy of a gas which follows the equation of state $P=\frac{RT}{v-b}-\frac{a}{v^2}$. Assume the internal energy C_v varies according to the relation $C_v=C_1+C_2T$, where C_1 and C_2 are constant.