注意：考試開始鈴響前，不得翻閱試題，
並不得書寫、畫記、作答。

國立清華大學 114 學年度碩士班考試入學試題

系所班組別：工程與系統科學系
乙組

科目代碼：3202

考試科目：熱力學

一作答注意事項一

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「▛ 由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

國立清華大學 114 學年度碩士班考試入學試題

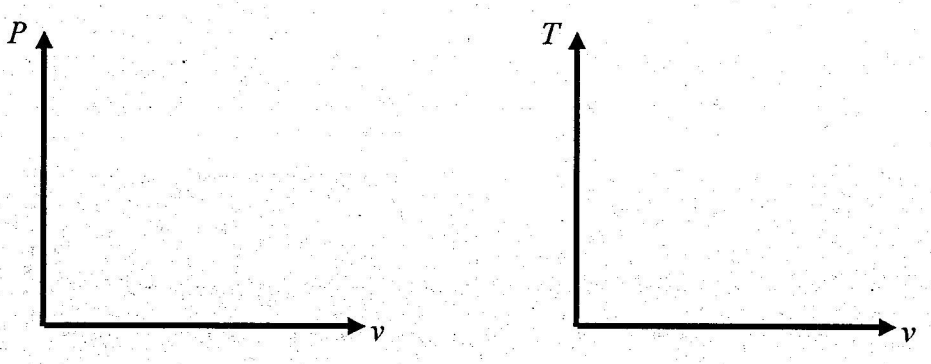
系所班組別：工程與系統科學系碩士班 乙組(0532)

考試科目（代碼）：熱力學 (3202)

Problem 1. Four conditions of water and their states are listed in the table below. Follow the steps below to identify their locations in the *P*-*v* and *T*-*v* diagrams. (25%)

Point	Temperature, pressure and specific volume	State
1	20 °C, 500 kPa, 0.001002 m^3/kg	Compressed liquid
2	152 °C, 500 kPa, 0.2 m^3/kg	Mixture of liquid & vapor; quality of 0.53
3	200 °C, 1400 kPa, 0.14302 m^3/kg	Superheated vapor
4	300 °C, 8581 kPa, 0.01762 m^3/kg	Mixture of liquid & vapor; quality of 0.8

- Step 1: Sketch the saturated liquid line, saturated vapor line and critical point in a pressure-specific volume (*P*-*v*) diagram and a temperature-specific volume (*T*-*v*) diagram. (6 pts)
- Step 2: Sketch the constant-temperature phase change process at 20, 152, 200 and 300 °C in the *P*-*v* diagram. (6 pts)
- Step 3: Sketch the constant-pressure phase change process at 500, 1400 and 8518 kPa in the *T*-*v* diagram. (6 pts)
- Step 4: Locate the four points in the *P*-*v* and *T*-*v* diagrams. (7 pts)



Problem 2. The general energy equation on a rate form is known to be (25%):

$$\frac{dE_{\text{C.V.}}}{dt} = \dot{Q}_{\text{C.V.}} - \dot{W}_{\text{C.V.}} + \dot{m}_i e_i - \dot{m}_e e_e + \dot{W}_{flow\ in} - \dot{W}_{flow\ out}$$

Answer the questions below:

A. Explain the meaning of each term in the equation of the 1st law of thermodynamics above. (8 pts)

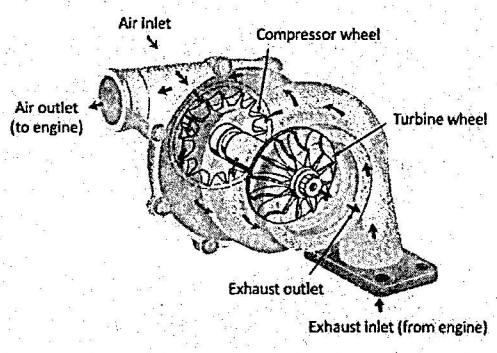
B. Explain how the general energy equation on a rate form above is expanded to the following form: (5 pts)

$$\frac{dE_{C.V.}}{dt} = \dot{Q}_{C.V.} - \dot{W}_{C.V.} + \dot{m}_i(e_i + P_i v_i) - \dot{m}_e(e_e + P_e v_e)$$

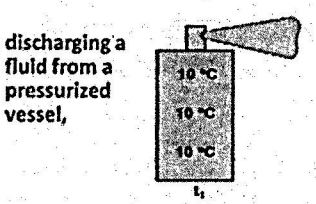
$$= \dot{Q}_{C.V.} - \dot{W}_{C.V.} + \dot{m}_i\left(h_i + \frac{1}{2}V_i^2 + gZ_i\right) - \dot{m}_e(h_e + \frac{1}{2}V_e^2 + gZ_e)$$

C. To the best of your knowledge, indicate in the image below how each term in the equation of the 1st law of thermodynamics in B is used to analyze the three components in the power generation system below: (12 pts)

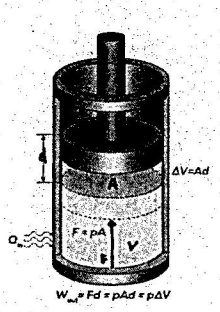
(a)



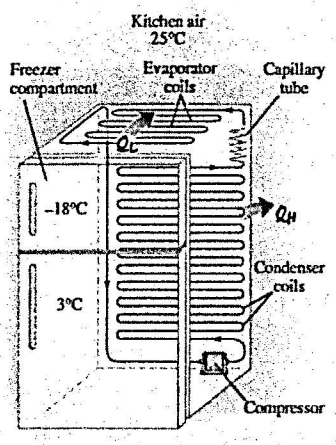
(b)

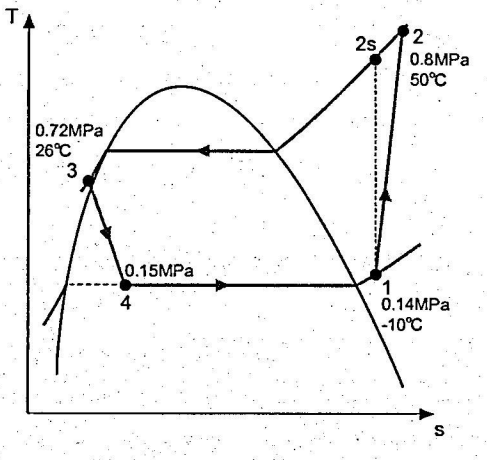


(c)



Problem 3. Refrigerators that produce refrigeration are used in our daily life. A household refrigerator and its components are shown in the image (left). Answer the questions below. (25%)

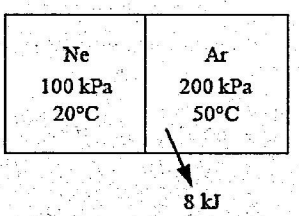




Source: Thermodynamics-An Engineering Approach by Cengel & Boles

Q1. Please indicate the components for their corresponding processes, 1-2, 2-3, 3-4 and 4-1, in the actual cycle of refrigeration in the *T-s* diagram (right). (8 pts)
Q2. Write out the equation to calculate the coefficient of performance (COP). (8 pts)
Q3. What thermodynamic properties do you need to determine for the equation of COP? (9 pts)

Problem 4. A container with two gas species, neon and argon are stored and separated by a partition. The given conditions are shown in the image below. The molar masses and specific heats of Ne and Ar are 20.18 kg/kmol, 39.95 kg/kmol, 0.6179 kJ/kg.°C, and 0.3122 kJ/kg.°C, respectively. (25%)



Q1. Estimate mole number of each gas species in the container. (7 pts)
Q2. If the partition in the box is removed and a heat loss takes place during the mixing process, how do you simply the 1st law below to evaluate the mixture temperature at its equilibrium state? The first law of thermodynamics for transient processes is expressed as: (6 pts)

$$\dot{Q}_{net,in} - \dot{W}_{net,out} + \sum \dot{m}_i\left(h_{i+}\frac{1}{2}\mathbf{V}_i^2 + gZ_i\right) - \sum \dot{m}_o\left(h_{o+}\frac{1}{2}\mathbf{V}_o^2 + gZ_o\right) = \dot{m}_2(u_2 +$$

$$\frac{1}{2}V_2^2 + gZ_2) - \dot{m}_1(u_1 + \frac{1}{2}V_1^2 + gZ_1)$$

Subscripts 1 and 2 are states; subscripts i and o are inlet and outlet, respectively.
Q3. Using the simply Calculate the mixture temperature at its equilibrium state. (6 pts)
Q4. Determine the mixture pressure at its equilibrium state. (6 pts)