

國立中央大學101學年度碩士班考試入學試題卷

所別：機械工程學系碩士班 丙組(熱流)(一般生) 科目：熱力學 共 1 頁 第 1 頁
 能源工程研究所碩士班 不分組(一般生)

本科考試可使用計算器，廠牌、功能不拘

*請在試卷答案卷(卡)內作答

1. A closed frictionless piston-cylinder device initially contains saturated vapor refrigerant-134a at 40°C (property table is given below). The refrigerant is now condensed at constant pressure to a saturated liquid. Calculate the heat transfer and work done during this process, in kJ/kg. Also, show the process on a P - v diagram (pressure-specific volume) with respect to saturated lines. (15%)

| Temp., T °C | Sat. press., P_{sat} kPa | Specific volume, m^3/kg | | Enthalpy, kJ/kg | | | Entropy, $kJ/kg \cdot K$ | | |
|------------------|-------------------------------|------------------------------|----------------------|-----------------------|--------------------|----------------------|-----------------------------|--------------------|----------------------|
| | | Sat. liquid, v_f | Sat. vapor, v_g | Sat. liquid, h_f | Evap., h_{fg} | Sat. vapor, h_g | Sat. liquid, s_f | Evap., s_{fg} | Sat. vapor, s_g |
| 40 | 1017.1 | 0.0008720 | 0.019952 | 108.26 | 163.00 | 271.27 | 0.39486 | 0.52049 | 0.91536 |
| 42 | 1072.8 | 0.0008786 | 0.018855 | 111.26 | 160.86 | 272.12 | 0.40425 | 0.51039 | 0.91464 |
| 44 | 1130.7 | 0.0008854 | 0.017824 | 114.28 | 158.67 | 272.95 | 0.41363 | 0.50027 | 0.91391 |
| 46 | 1191.0 | 0.0008924 | 0.016853 | 117.32 | 156.43 | 273.75 | 0.42302 | 0.49012 | 0.91315 |
| 48 | 1253.6 | 0.0008996 | 0.015939 | 120.39 | 154.14 | 274.53 | 0.43242 | 0.47993 | 0.91236 |

2. A rigid, insulated tank with internal volume v that is initially evacuated is connected through a valve to a supply line containing nitrogen at pressure p_{in} and temperature T_{in} with enthalpy h_{in} . Now the valve is opened, allowing nitrogen to flow slowly into the tank until the pressure reaches P_{in} . Determine the final internal energy. (10%)
3. Derive the relation between the specific heat c_p , c_v , and gas constant R for ideal gases. The subscript p and v denote the properties at constant pressure and constant volume, respectively. (10%)
4. Is it possible to compress ideal gas isothermally in an adiabatic piston-cylinder device (closed system)? Explain (10%)
5. Explain the entropy transfer and entropy generation of a realistic thermodynamic process in terms of its mechanism and its possible value (positive, negative or zero). (10%)
6. The heat engine can be classified as internal combustion engine (ICE) and external combustion engine (ECE). Briefly the difference of these two engines and give two examples of engine for ICE and ECE. (15%)
7. For a thermodynamic system, p , T , and v represent the pressure, temperature, and specific volume, respectively. Prove it must be
- $$\left(\frac{\partial p}{\partial v}\right)_T \left(\frac{\partial v}{\partial T}\right)_p \left(\frac{\partial T}{\partial p}\right)_v = -1 \quad (10\%)$$
8. What is the Joule-Thomson coefficient? Why this coefficient is important in the design of a refrigeration system? Explain it as much as you can. (10%)
9. In the atmospheric condition ($p=101.325$ kPa), the measured dry and wet-bulb temperature are 25 °C and 15 °C, respectively. If the c_p for air is taken as 1.005 kJ/(kg.K), and the properties of water are listed as below. Find the corresponding specific humidity and relative humidity. (10%)

| Temperature (°C) | Saturation pressure (kPa) | h_f (kJ/kg) | h_g (kJ/kg) |
|------------------|---------------------------|---------------|---------------|
| 25 | 3.1698 | 104.83 | 2546.5 |
| 15 | 1.7057 | 62.982 | 2528.3 |