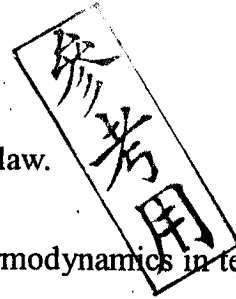


系所別:

大氣物理研究所

科目:

熱力學



- 1) Please answer the following questions briefly. (5% each)
- What is an ideal gas? Give an equation describing the ideal gas law.
  - State the zeroth law of thermodynamics.
  - What is the definition of enthalpy? Express the first law of thermodynamics in terms of enthalpy. Under what kind of condition is the enthalpy conserved?
  - How is the reversible process defined?
  - When you compress a container full of gas, what is the difference between an isothermal compression process and an adiabatic compression process?
  - What is a free expansion process? How much work is done during the process?
  - What is an isentropic process?
  - Illustrate a Carnot cycle on a  $P$ - $V$  diagram and a  $T$ - $V$  diagram, respectively. On the diagram please indicate the type of thermodynamic process for each stage in the whole cycle.
- 2) For a system of  $N$  molecules of  $O_2$  at a state of high temperature,
- list all possible temperature-dependent forms of energy that an  $O_2$  molecule may have,
  - how many degrees of freedom that an  $O_2$  molecule may have?
  - what is the total thermal energy of this system? (15%)
- 3) When two bodies with initially different temperatures  $T_{1i}$  and  $T_{2i}$  are allowed to interact isobarically with each other but not with their surroundings (i.e., an isolated system of two components). What information about the final temperatures  $T_{1f}$  and  $T_{2f}$  can you get if only the first law of thermodynamics is applied? (15%)
- 4) The potential temperature  $\Theta$  of an air parcel at a height in the atmosphere with pressure  $p$  and temperature  $T$  is defined as the temperature this air parcel would have if it were brought adiabatically and reversibly to a reference height where the pressure is  $p_0$ . From the Poisson's relation,  $p^{1-\gamma/\gamma} T = \text{constant}$ , show that  $\Theta = T \left( \frac{p_0}{p} \right)^{R/c_p}$ , where  $\gamma = c_p/c_v$ ,  $R$  is the gas constant,  $c_p$  and  $c_v$  are specific heat capacity at constant pressure and constant volume, respectively. (15%)
- 5) Please answer the following questions concerning the van der Waals equation of state:
- In what kind of situation should this equation of state be applied?
  - What additional factors are accounted for in this equation of state?
  - Define the critical temperature with van der Waals isotherms on a  $P$ - $V$  diagram. (15%)