(25%) 1. (a) From the first law of thermodynamics, derive the following relation

$$Cp = Cv + R$$

where Cp and Cv are the specific heats per mole of an ideal gas at constant pressure and constant volume respectively.

(b) Show that the relation $PV^\gamma = $ constant　(Poisson's equation) holds in a quasi-static adiabatic process of an ideal gas.

where $\gamma = Cp/Cv$.

(25%) 2. State the second law of thermodynamics with both Clausius statement and the Kelvin-Planck statement, then prove that both statements are equivalent. (Please draw the conceptual diagrams to illustrate your statements and proof.)

(25%) 3. A Carnot cycle is illustrated in the following diagram.
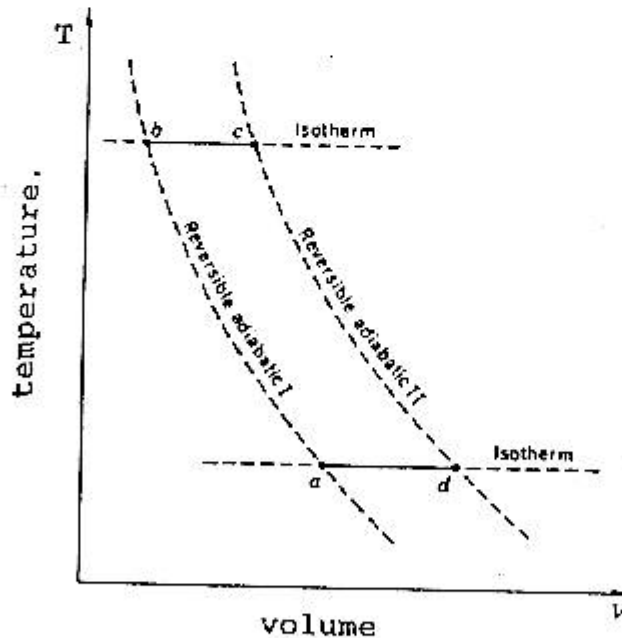
(a) State the processes of the whole cycle.
(b) Draw the TS diagram of this cycle.(T, temperature, S, entropy)
(c) How to calculate the efficiency of a Carnot engine?

(25%) 4. Explain the following terms and statements.

(a) temperature.
(b) equation of state.
(c) phase change.
(d) ideal gas.
(e) irreversible process.