Problem 1

Prove the following relations for multi-component ideal gas.

$$\kappa_S = \frac{\bar{c}}{\bar{c}+1}\frac{1}{P} \quad \text{and} \quad c_P = (\bar{c}+1)R$$

where $\bar{c} = \frac{1}{N}\sum_j c_j N_j$.

Problem 2

The heat capacity of two bodies is given by $C(T) = \alpha + \beta T$, where $\alpha = 8$ J/K and $\beta = 2 \times 10^{-2}$ J/K^2 are constant. The two bodies have initial temperatures of 300K and 600K. (a) What will be the final temperature if the two bodies are brought into thermal contact? (b) Calculate the total change in the entropy.

Problem 3

One mole of an ideal van der Waal's fluids is taken from the intial states (T_0, v_0) to the final states (T_f, v_f). A second system is constrained to have a fixed volume and its initial temperature is T_{2o} whose heat capacity varies linearly with temperature $C_2(T) \sim T$. What is the maximum work that can be delivered to a reversible work source.

Problem 4

(a) A Carnot engine operates between 317^o and 67^o Celcius. What is its efficiency? (b) A Carnot engine is designed to operate between 480K and 300K. Assuming that the engine actually produces 1.2 kJ of mechanical energy per kilocalorie of heat absorbed, compare the actual efficiency with the theoretical maximum efficiency. (c) What is the maximum amount of work that a Carnot engine can perform per kilocalorie if it absorbs heat at 427 ^{o}C and exhausts heat at 177 ^{o}C?