PHY 540 Statistical Mechanics
Homework 1 Hints

1.1 Entropy increase in irreversible processes

(a) Calculate entropy and its change by integrating

$$\int_{T_0,V_0}^{T,V} \frac{\delta Q}{T} = \int_{T_0,V_0}^{T,V} \left(\frac{1}{T}\, dE + \frac{P}{T}\, dV \right) \tag{1}$$

along any reversible process connecting the initial (T_0, V_0) and the final (T, V) states.
(b) Find the new equilibrium point under the conditions, and use results of (a) to find the change of the entropy.

1.2 Thermodynamic identities

(a) Write the expression as a Jacobian and use the Jacobian properties
(b) Similar to $\left(\frac{\partial E}{\partial V}\right)_T$ in the lecture.
(c) Use the expression for $\left(\frac{\partial H}{\partial P}\right)_T$ to find C_P dependence on T; the result should depend only on the equation of state $V(T, P)$.
(d) From the expressions for $\left(\frac{\partial E}{\partial V}\right)_T$ and $\left(\frac{\partial H}{\partial P}\right)_T$, find the differential equation for dT depending on dV and dP, and integrate it.

1.3 Thermodynamic potentials

Determine the EoS (pressure as a function of T, V) from the expression for work. Find internal energy by integrating C_V. Use thermodynamic identities to determine S, H, F, G.

1.4 Van der Waals gas

Apply the equation for $\left(\frac{\partial E}{\partial V}\right)_T$.