[tex41] Heat capacity of vapor in equilibrium with liquid phase

Consider 1 mol of a simple fluid. Use $V_{gas} \gg V_{liq}$, $pV_{gas} = RT$. The heat capacities in the gas and liquid phases are $C_p^{(gas)}$ and $C_p^{(liq)}$, respectively. The latent heat of vaporization is $L(T)$.

(a) Show that the heat capacity $C_{coex} \doteq T(dS/dT)_{coex}$ of vapor for a process along which the vapor is maintained in equilibrium with the liquid phase can be expressed in the following two alternative ways:

$$C_{coex} = C_p^{(gas)} - \frac{L}{T} = C_p^{(liq)} + T\frac{d}{dT}\left(\frac{L}{T}\right).$$

Use the result of [tex124] to derive the second expression.

Solution: