[tex173] Effect of mixing on chemical potential

Consider n_1 and n_2 moles of two dilute gases in a rigid conducting box, separated by a mobile conducting wall. The equilibrium conditions are $n_1 + n_2 = n$, $T_1 = T_2$, and $p_1 = p_2$. From [tex15] we know that the Gibbs free energy of a classical ideal gas is

$$G(T, p, n) = -nRT \left[\ln \left(\frac{T}{T_0} \right)^{\alpha+1} - \ln \left(\frac{p}{p_0} \right) \right],$$

where T_0, p_0 are reference values and α depends on the molecular composition of the gas particles. (a) Show that the change in Gibbs free energy in the wake of removing the wall and after waiting the restoration of equilibrium is

$$\Delta G = RT \left[n_1 \ln \left(\frac{n_1}{n} \right) + n_2 \ln \left(\frac{n_2}{n} \right) \right].$$

(b) Show that the change in chemical potential of the two gases becomes

$$\Delta \mu_i = RT \ln \left(\frac{n_i}{n} \right), \quad i = 1, 2.$$

Solution: