Day 13 Equations and Practice Problems

Log Plots Equations

- Clausis-Clapeyron:

$$P = P_{ref} \exp\left[-\frac{\Delta \underline{H}_{vap}}{R}\left(\frac{1}{T} - \frac{1}{T_{ref}}\right)\right]$$

- Internal flow:

$$Nu = 0.023\,\mathrm{Re}^{0.8}\,\mathrm{Pr}^{0.3}$$

Practice Problem 1

Recall the following equations for the temperature changes and worked performed during an adiabatic compression:

$$T = T_0\left(\frac{P}{P_0}\right)^{\frac{\gamma-1}{\gamma}}$$

$$W = m_{air} C_p \left(T - T_0\right)$$

In the equations above T represents the actual temperature, T_0 represents the initial temperature, P represents the actual pressure, P_0 represents the initial pressure, m_{air} represents the mass of air, C_P represents the heat capacity of the air and is a constant, while γ represents a ratio of heat capacities and is also a constant.

For this problem, you will use the following values:

P_0 = 1 atm

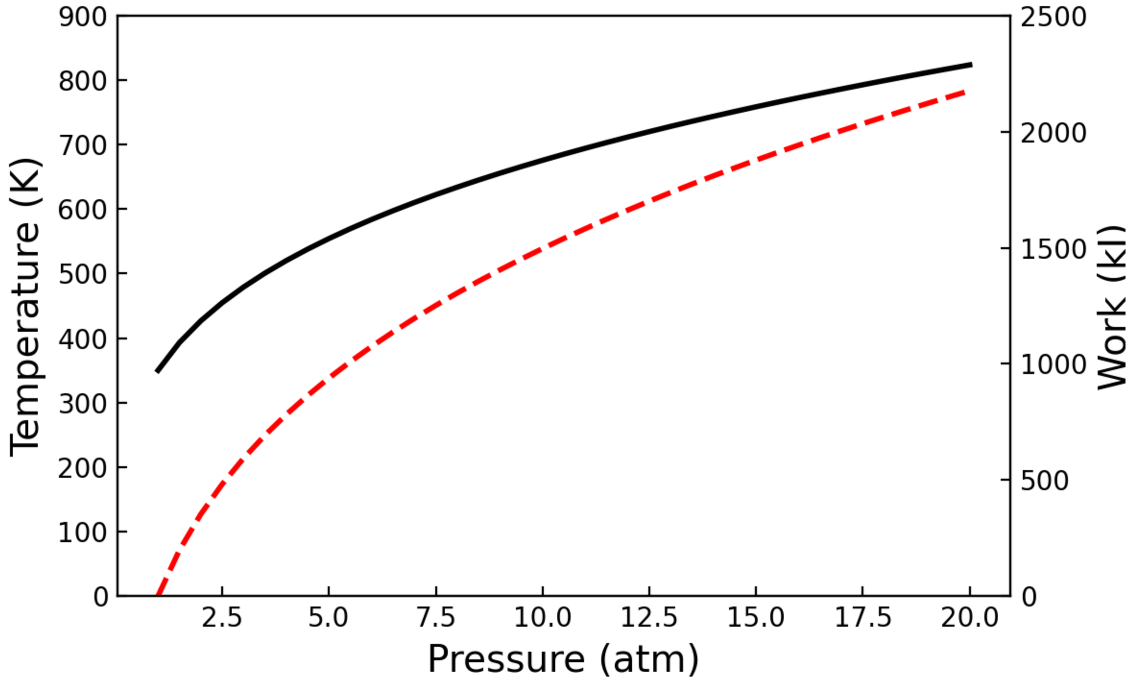
T_0 = 350 K

γ = 1.4

C_P = 1.021 kJ/kg*K

m_{air} = 4.5 kg

Follow the TODOs in the file to complete this problem. A completed figure is on the next page.



Practice Problem 2

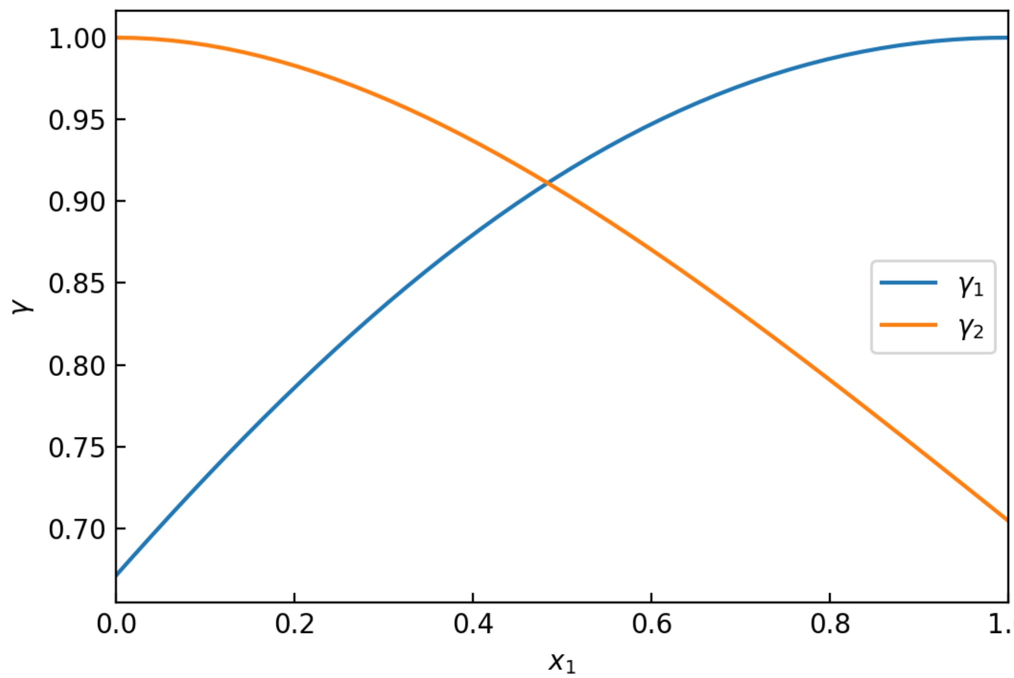
Activity coefficients are one way to quantify the behavior of components in a mixture. One activity coefficient is called the Wilson model, and, for a binary mixture, it takes the following form:

$$\ln \gamma_1 = -\ln\left(x_1 + x_2\Lambda_{12}\right) + x_2\left[\frac{\Lambda_{12}}{x_1 + x_2\Lambda_{12}} - \frac{\Lambda_{21}}{x_1\Lambda_{21} + x_2}\right]$$

$$\ln \gamma_2 = -\ln\left(x_2 + x_1\Lambda_{21}\right) - x_1\left[\frac{\Lambda_{12}}{x_1 + x_2\Lambda_{12}} - \frac{\Lambda_{21}}{x_1\Lambda_{21} + x_2}\right]$$

where γ_i (the Greek letter gamma) is activity coefficient of species *i*. There are two model parameters: Λ_{12} and Λ_{21}. For this problem, you will create a function that makes a figure for the activity coefficients of both species using the Wilson model over the full range of compositions.

Follow the TODOs in the file to complete this problem. A completed figure is on the next page.



1.00
0.95
0.90
0.85
0.80
0.75
0.70
γ
0.0
0.2
0.4
0.6
0.8
1.0
x_1
γ_1
γ_2