$ORIGIN := 1$

$T := 800$

Methane

$\Delta H_{f298} := -74900$ $\Delta G_{f298} := -50870$

$a := 36.155$ $b := -0.511 \cdot 10^{-1}$ $c := 2.215 \cdot 10^{-4}$ $d := -1.824 \cdot 10^{-7}$

$e := 4.899 \cdot 10^{-11}$

$\Delta G :=$

$n_H \leftarrow 2$

$n_O \leftarrow 0$

$n_C \leftarrow 1$

$A \leftarrow a - 27.004 n_H - 29.705 n_O - 17.152 n_C$

$B \leftarrow b - \left(0.119 n_H - 0.099 n_O + 4.273 \cdot 10^{-2} n_C\right) \cdot 10^{-1}$

$C \leftarrow c - \left(-0.241 n_H + 0.399 n_O\right) \cdot 10^{-4}$

$D \leftarrow d - \left(0.215 n_H - 0.339 n_O\right) \cdot 10^{-7}$

$E \leftarrow e - \left(-0.615 n_H + 0.918 n_O\right) \cdot 10^{-11}$

$F \leftarrow 8.7879 \cdot 10^{5} \cdot n_C$

$f(z) \leftarrow A + B \cdot z + C \cdot z^2 + D \cdot z^3 + E \cdot z^4 + F \cdot z^{-2}$

$I(y) \leftarrow \Delta H_{f298} + \int_{298}^{y} f(z)\, dz$

$Y \leftarrow \int_{298}^{T} \frac{I(y)}{y^2}\, dy$

$\Delta G \leftarrow T \cdot \left(\frac{\Delta G_{f298}}{298} - Y\right)$

ΔG

$\Delta G = -2.093 \times 10^{3}$

Carbon Monoxide

$\Delta H_{f298} := -110600$ $\Delta G_{f298} := -137400$

$a := 29.651$ $b := -0.007 \cdot 10^{-1}$ $c := 0.183 \cdot 10^{-4}$ $d := -0.094 \cdot 10^{-7}$

$e := 0.108 \cdot 10^{-11}$

$\Delta G :=$

$n_H \leftarrow 0$

$n_O \leftarrow \frac{1}{2}$

$n_C \leftarrow 1$

$A \leftarrow a - 27.004 n_H - 29.705 n_O - 17.152 n_C$

$B \leftarrow b - \left(0.119 n_H - 0.099 n_O + 4.273 \cdot 10^{-2} n_C\right) \cdot 10^{-1}$

$C \leftarrow c - \left(-0.241 n_H + 0.399 n_O\right) \cdot 10^{-4}$

$D \leftarrow d - \left(0.215 n_H - 0.339 n_O\right) \cdot 10^{-7}$

$E \leftarrow e - \left(-0.615 n_H + 0.918 n_O\right) \cdot 10^{-11}$

$F \leftarrow 8.7879 \cdot 10^{5} \cdot n_C$

$f(z) \leftarrow A + B \cdot z + C \cdot z^{2} + D \cdot z^{3} + E \cdot z^{4} + F \cdot z^{-2}$

$I(y) \leftarrow \Delta H_{f298} + \int_{298}^{y} f(z)\, dz$

$Y \leftarrow \int_{298}^{T} \frac{I(y)}{y^{2}}\, dy$

$\Delta G \leftarrow T \cdot \left(\frac{\Delta G_{f298}}{298} - Y\right)$

ΔG

$\Delta G = -1.835 \times 10^{5}$

Water

$\Delta H_{f298} := -242000$ $\Delta G_{f298} := -228800$

$a := 33.763$ $b := -0.006 \cdot 10^{-1}$ $c := 0.224 \cdot 10^{-4}$ $d := -0.1 \cdot 10^{-7}$

$e := 0.11 \cdot 10^{-11}$

$\Delta G :=$

$n_H \leftarrow 1$

$n_O \leftarrow \frac{1}{2}$

$n_C \leftarrow 0$

$A \leftarrow a - 27.004 n_H - 29.705 n_O - 17.152 n_C$

$B \leftarrow b - \left(0.119 n_H - 0.099 n_O + 4.273 \cdot 10^{-2} n_C\right) \cdot 10^{-1}$

$C \leftarrow c - \left(-0.241 n_H + 0.399 n_O\right) \cdot 10^{-4}$

$D \leftarrow d - \left(0.215 n_H - 0.339 n_O\right) \cdot 10^{-7}$

$E \leftarrow e - \left(-0.615 n_H + 0.918 n_O\right) \cdot 10^{-11}$

$F \leftarrow 8.7879 \cdot 10^{5} \cdot n_C$

$f(z) \leftarrow A + B \cdot z + C \cdot z^2 + D \cdot z^3 + E \cdot z^4 + F \cdot z^{-2}$

$I(y) \leftarrow \Delta H_{f298} + \int_{298}^{y} f(z)\, dz$

$Y \leftarrow \int_{298}^{T} \frac{I(y)}{y^2}\, dy$

$\Delta G \leftarrow T \cdot \left(\frac{\Delta G_{f298}}{298} - Y\right)$

ΔG

$\Delta G = -2.045 \times 10^{5}$

Carbon Dioxide

$\Delta H_{f298} := -393800$ $\Delta G_{f298} := -394600$

$a := 29.268$ $b := -0.224 \cdot 10^{-1}$ $c := 2.653 \cdot 10^{-4}$ $d := -4.153 \cdot 10^{-7}$

$e := 20.057 \cdot 10^{-11}$

$\Delta G :=$

$n_H \leftarrow 0$

$n_O \leftarrow 1$

$n_C \leftarrow 1$

$A \leftarrow a - 27.004 n_H - 29.705 n_O - 17.152 n_C$

$B \leftarrow b - \left(0.119 n_H - 0.099 n_O + 4.273 \cdot 10^{-2} n_C\right) \cdot 10^{-1}$

$C \leftarrow c - \left(-0.241 n_H + 0.399 n_O\right) \cdot 10^{-4}$

$D \leftarrow d - \left(0.215 n_H - 0.339 n_O\right) \cdot 10^{-7}$

$E \leftarrow e - \left(-0.615 n_H + 0.918 n_O\right) \cdot 10^{-11}$

$F \leftarrow 8.7879 \cdot 10^{5} \cdot n_C$

$f(z) \leftarrow A + B \cdot z + C \cdot z^2 + D \cdot z^3 + E \cdot z^4 + F \cdot z^{-2}$

$I(y) \leftarrow \Delta H_{f298} + \int_{298}^{y} f(z)\, dz$

$Y \leftarrow \int_{298}^{T} \frac{I(y)}{y^2}\, dy$

$\Delta G \leftarrow T \cdot \left(\frac{\Delta G_{f298}}{298} - Y\right)$

ΔG

$\Delta G = -3.954 \times 10^{5}$

$y_{CH4} := 0.06$ $y_{H2O} := 0.3$ $y_{CO} := 0.01$ $y_{CO2} := 0.01$ $y_{H2} := 0.4$

$\lambda_C := 1 \qquad \lambda_H := 4 \qquad \lambda_O := 20 \qquad n := 8$

Given

$$\ln\left(y_{CH4}\right) + \lambda_C + 4\lambda_H = \frac{2093}{8.314 \cdot 800}$$

$$\ln\left(y_{H2O}\right) + 2\lambda_H + \lambda_O = \frac{204500}{8.314 \cdot 800}$$

$$\ln\left(y_{CO}\right) + \lambda_C + \lambda_O = \frac{183500}{8.314 \cdot 800}$$

$$\ln\left(y_{CO2}\right) + \lambda_C + 2\lambda_O = \frac{395400}{8.314 \cdot 800}$$

$$\ln\left(y_{H2}\right) + 2\lambda_H = 0$$

$$y_{CH4} + y_{CO} + y_{CO2} = \frac{1}{n}$$

$$4y_{CH4} + 2y_{H2O} + 2y_{H2} = \frac{12}{n}$$

$$y_{H2O} + y_{CO} + 2y_{CO2} = \frac{4}{n}$$

$$y_{CH4} + y_{H2O} + y_{CO} + y_{CO2} + y_{H2} = 1$$

$$\text{Find}\left(y_{CH4}, y_{H2O}, y_{CO}, y_{CO2}, y_{H2}, \lambda_C, \lambda_H, \lambda_O, n\right) = \begin{pmatrix} 0.065 \\ 0.473 \\ 0.02 \\ 0.077 \\ 0.366 \\ 1.035 \\ 0.503 \\ 30.49 \\ 6.193 \end{pmatrix}$$