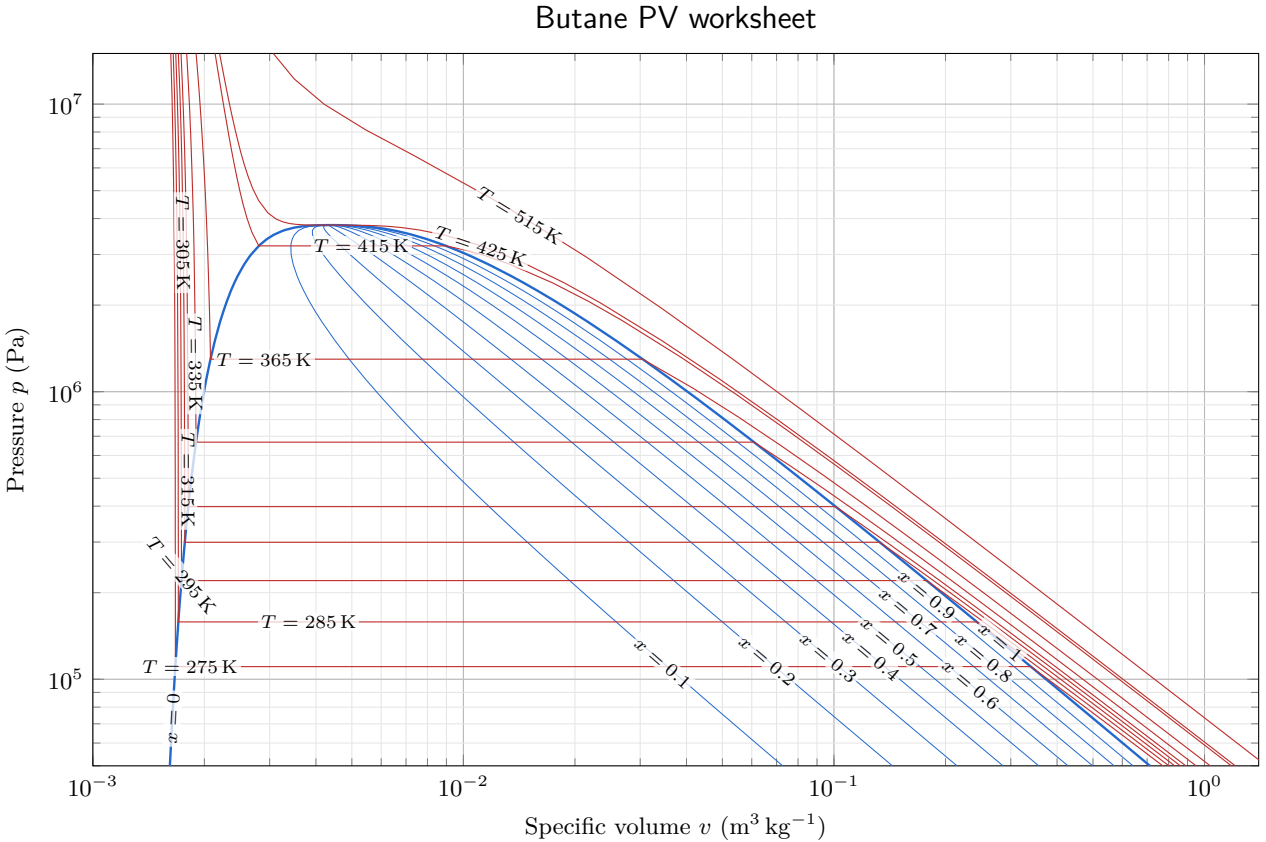
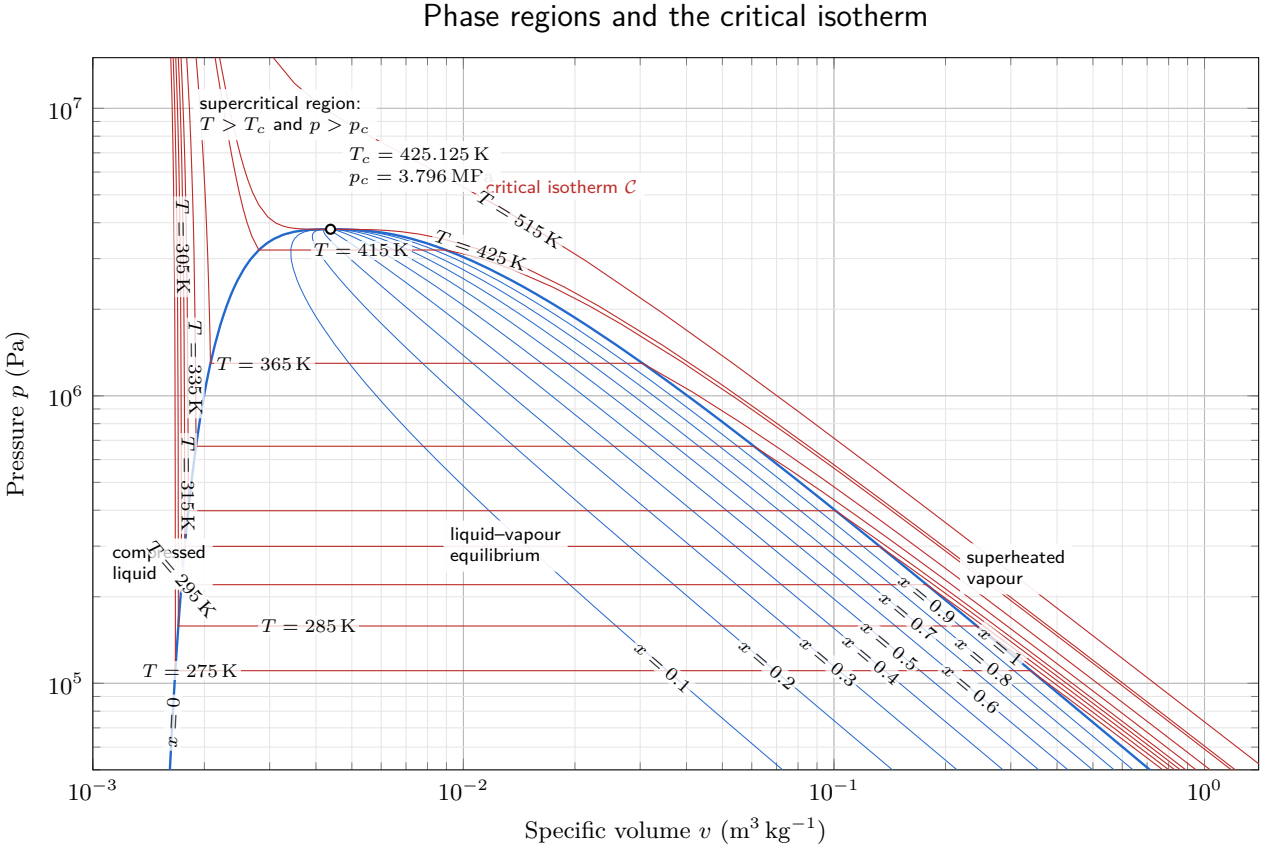
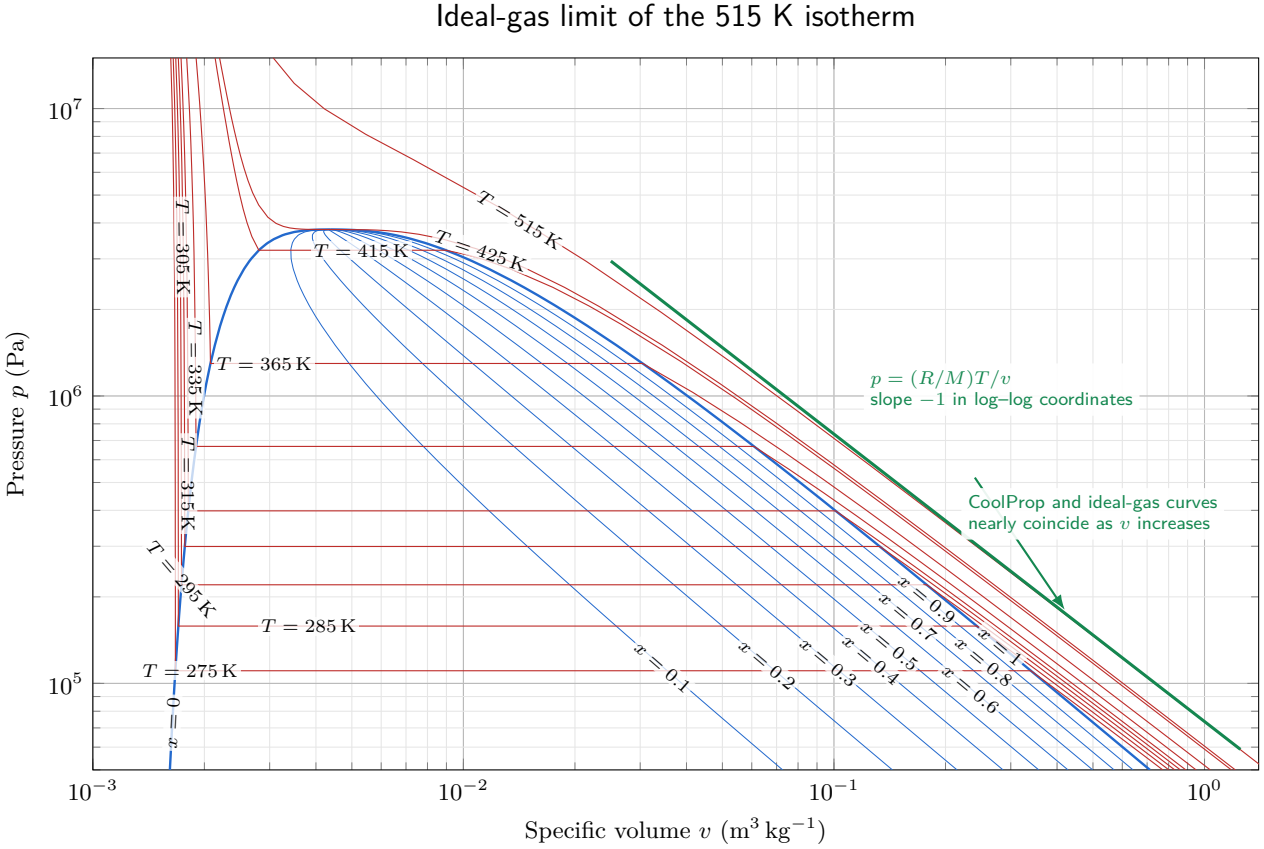
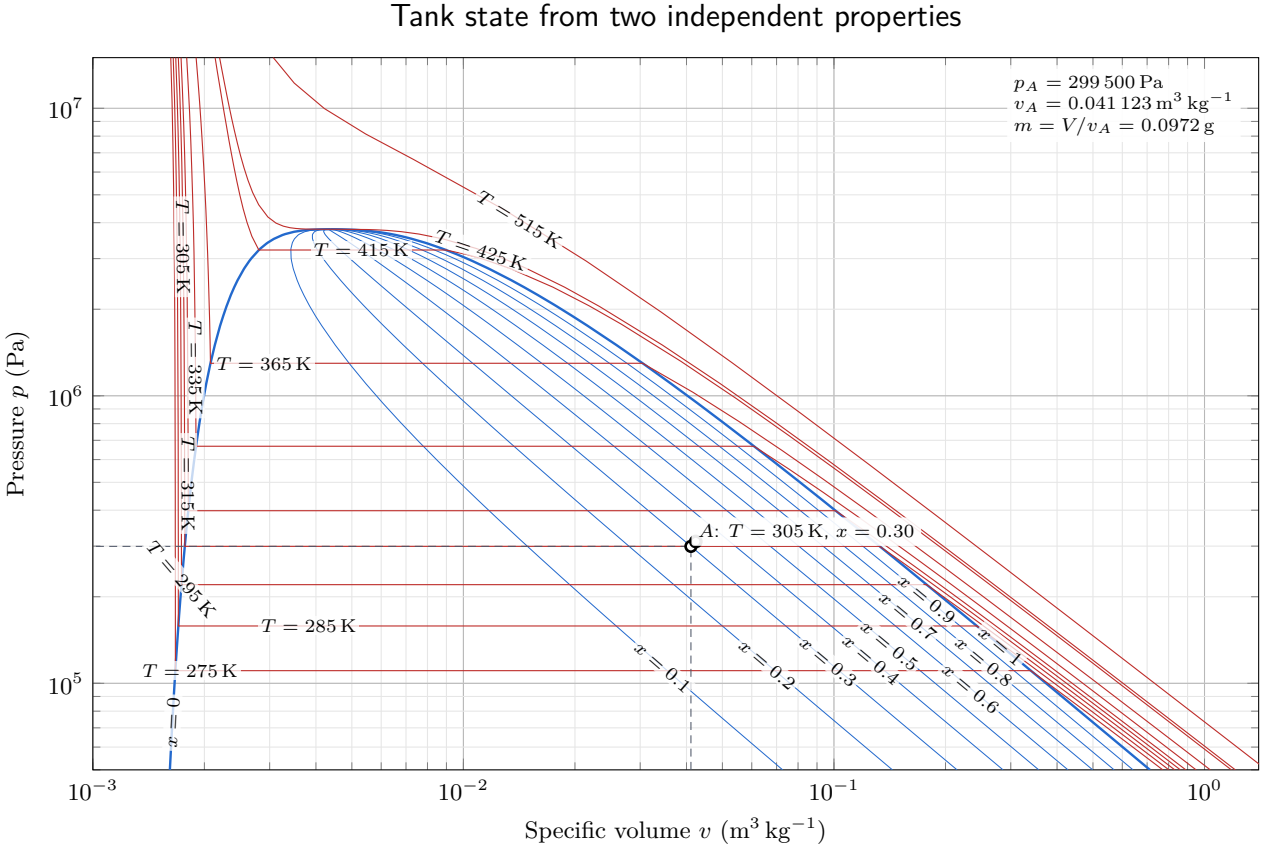
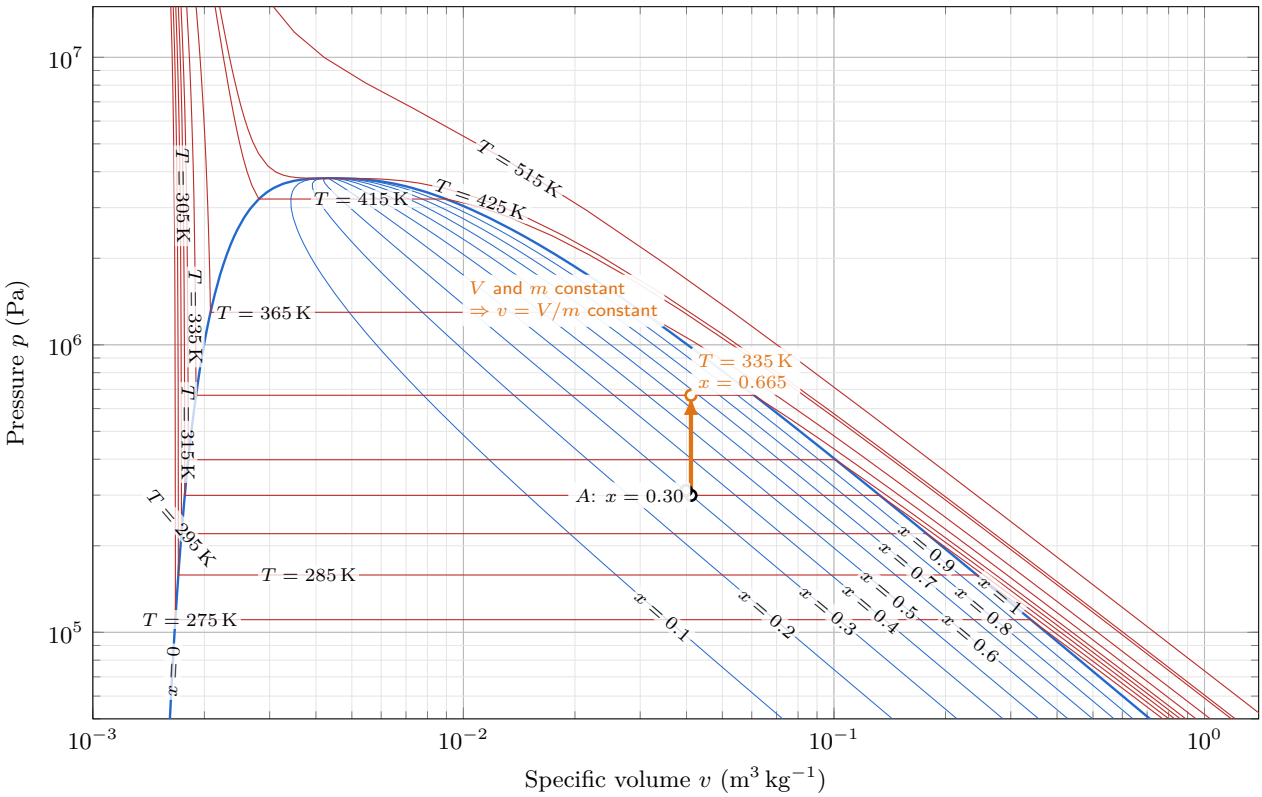

Butane PV worksheet
Pressure p (Pa)
Specific volume v ($\mathrm{m^3\,kg^{-1}}$)
10^{7}
10^{6}
10^{5}
10^{-3}
10^{-2}
10^{-1}
10^{0}
$T = 515\,\mathrm{K}$
$T = 425\,\mathrm{K}$
$T = 415\,\mathrm{K}$
$T = 365\,\mathrm{K}$
$T = 335\,\mathrm{K}$
$T = 315\,\mathrm{K}$
$T = 305\,\mathrm{K}$
$T = 295\,\mathrm{K}$
$T = 285\,\mathrm{K}$
$T = 275\,\mathrm{K}$
$x = 0$
$x = 0.1$
$x = 0.2$
$x = 0.3$
$x = 0.4$
$x = 0.5$
$x = 0.6$
$x = 0.7$
$x = 0.8$
$x = 0.9$
$x = 1$


Phase regions and the critical isotherm
supercritical region:
$T > T_c$ and $p > p_c$
$T_c = 425.125\,\mathrm{K}$
$p_c = 3.796\,\mathrm{MP}$
critical isotherm $\mathcal{C}$
$T = 515\,\mathrm{K}$
$T = 425\,\mathrm{K}$
$T = 415\,\mathrm{K}$
$T = 365\,\mathrm{K}$
$T = 335\,\mathrm{K}$
$T = 315\,\mathrm{K}$
$T = 305\,\mathrm{K}$
$T = 295\,\mathrm{K}$
$T = 285\,\mathrm{K}$
$T = 275\,\mathrm{K}$
$x = 0$
$x = 0.1$
$x = 0.2$
$x = 0.3$
$x = 0.4$
$x = 0.5$
$x = 0.6$
$x = 0.7$
$x = 0.8$
$x = 0.9$
$x = 1$
compressed liquid
liquid–vapour equilibrium
superheated vapour
10^7
10^6
10^5
Pressure p (Pa)
10^{-3}
10^{-2}
10^{-1}
10^0
Specific volume v ($\mathrm{m^3\,kg^{-1}}$)


Ideal-gas limit of the 515 K isotherm
Pressure p (Pa)
Specific volume v ($\mathrm{m^3\,kg^{-1}}$)
10^{7}
10^{6}
10^{5}
10^{-3}
10^{-2}
10^{-1}
10^{0}
$T = 515\,\mathrm{K}$
$T = 425\,\mathrm{K}$
$T = 415\,\mathrm{K}$
$T = 365\,\mathrm{K}$
$T = 335\,\mathrm{K}$
$T = 315\,\mathrm{K}$
$T = 305\,\mathrm{K}$
$T = 295\,\mathrm{K}$
$T = 285\,\mathrm{K}$
$T = 275\,\mathrm{K}$
$x = 0$
$x = 0.1$
$x = 0.2$
$x = 0.3$
$x = 0.4$
$x = 0.5$
$x = 0.6$
$x = 0.7$
$x = 0.8$
$x = 0.9$
$x = 1$
$p = (R/M)T/v$
slope -1 in log–log coordinates
CoolProp and ideal-gas curves
nearly coincide as v increases


Tank state from two independent properties
$p_A = 299\,500\,\mathrm{Pa}$
$v_A = 0.041\,123\,\mathrm{m^3\,kg^{-1}}$
$m = V/v_A = 0.0972\,\mathrm{g}$
$T = 515\,\mathrm{K}$
$T = 425\,\mathrm{K}$
$T = 415\,\mathrm{K}$
$T = 365\,\mathrm{K}$
$T = 335\,\mathrm{K}$
$T = 315\,\mathrm{K}$
$T = 305\,\mathrm{K}$
$T = 295\,\mathrm{K}$
$T = 285\,\mathrm{K}$
$T = 275\,\mathrm{K}$
$x = 0$
$x = 0.1$
$x = 0.2$
$x = 0.3$
$x = 0.4$
$x = 0.5$
$x = 0.6$
$x = 0.7$
$x = 0.8$
$x = 0.9$
$x = 1$
A: $T = 305\,\mathrm{K}$, $x = 0.30$
10^7
10^6
10^5
10^{-3}
10^{-2}
10^{-1}
10^0
Pressure p (Pa)
Specific volume v ($\mathrm{m^3\,kg^{-1}}$)


Heating a closed rigid butane tank
Pressure p (Pa)
Specific volume v ($\mathrm{m^3\,kg^{-1}}$)
10^{7}
10^{6}
10^{5}
10^{-3}
10^{-2}
10^{-1}
10^{0}
$T = 515\,\mathrm{K}$
$T = 425\,\mathrm{K}$
$T = 415\,\mathrm{K}$
$T = 365\,\mathrm{K}$
$T = 335\,\mathrm{K}$
$T = 315\,\mathrm{K}$
$T = 305\,\mathrm{K}$
$T = 295\,\mathrm{K}$
$T = 285\,\mathrm{K}$
$T = 275\,\mathrm{K}$
V and m constant
$\Rightarrow v = V/m$ constant
$T = 335\,\mathrm{K}$
$x = 0.665$
A: $x = 0.30$
$x = 0$
$x = 0.1$
$x = 0.2$
$x = 0.3$
$x = 0.4$
$x = 0.5$
$x = 0.7$
$x = 0.9$
$x = 1$
$x = 0.8$
$x = 0.6$