ME215
Prob 4

1 → 2 \quad P = \text{const}\quad \frac{V}{V_1} = \text{const}

2 → 3 \quad P = \text{const}\quad V = \text{const}

3 → 1 \quad PV = \text{const}

\begin{align*}
\text{Compensation} & \\
\text{Heating} & \\
\text{Expansion} & \\
\end{align*}

Note \( V_3 = V_2 \).

\[ W_{1-2} = \int_{V_1}^{V_2} PDV = P_1 (V_2 - V_1) \]

Prob 3

\begin{align*}
\text{Prob 3} & \\
P_1 &= - \\
V_1 &= - \\
V_2 &= - \\
\end{align*}

Linear P vs V \rightarrow \text{straight line}

\[ W_{1-2} = \frac{(P_1 + P_2)}{2} (V_2 - V_1) \]

\[ = \frac{1}{2} (V_2 - V_1)(P_2 - P_1) + P_1 (V_2 - V_1) \]
The kinetic energy of a particle is given by:

\[ KE = \frac{1}{2} m v^2 \]

Units are \( \frac{1}{2} \text{lbm} \left( \frac{\text{ft}}{s} \right)^2 \):

\[ \frac{\text{ft}^2 \text{lbm}}{s^2} \times \frac{1}{32.174 \text{ ft lbm}} = \text{ft lbm} \]

\[ = 8 \text{ ft lbm} \]

\[ \left( \frac{1 \text{ N} - \text{m s}^2}{\text{kg m}} \right) \]

Phase Change of a Pure Substance:
Recall the \( T-V \) diagram and the \( P_{\text{SAT}}-T_{\text{SAT}} \) diagram:

- Critical point
- SAT
- VAP
- SAT LIQ
- Compressed liquid or superheated vapor

These diagrams represent data in property tables in appendix.
First two columns have Porr for every T from triple point to critical point.

During phase change, P and T are not independent. They are related by first two columns in A-4.

'f' denotes saturated liquid property
'g' denotes saturated vapor property

During phase change, a pseudo-property, quality, is defined

\[ \text{quality} = \chi = \frac{M_{\text{vap}}}{M_{\text{liq}} + M_{\text{vap}}} \]

The quality is used to compute the average properties for the mixture.

\[ V_{\text{mix}} = \chi V_f + (1 - \chi) V_g \]

\[ = V_f + \chi V_{sg} \]

where \( V_{sg} = V_g - V_f \)

\( \chi \) always compute \( \chi \) for 2-phase mixture \( \chi \)
Note: \( U_{\text{mix}} = U_f + x U_g \)

\( U = \text{internal energy} \)

Table A-6 \( \rightarrow \) Superheated Water

\( U = U(P, T) \)

\( U = U(P, T) \)

Liquid region

\( u_f = 392 \text{ Btu/lb} \)