

NAME:

AME 20231, Thermodynamics

Examination 1

Prof. J. M. Powers

15 February 2024

1. (5) A volume of 10 m^3 contains 1 kmole of N_2 at 300 K. Assuming an ideal gas, find the mass contained in the volume and its pressure.
2. (15) N_2 has $P = 100 \text{ kPa}$ and $T = 105 \text{ K}$. Estimate the specific volume via
 - (a) the ideal gas law, and
 - (b) the superheated N_2 tables.
3. (30) N_2 has initially $T_1 = 70 \text{ K}$, $x_1 = 0.001$.
 - (a) Find P_1 and v_1 at the initial state.
 - (b) The N_2 is heated in an isochoric process until a saturated state is reached with no gas present. Find the final P_2 , T_2 , and v_2 .
 - (c) Determine if the final phase is a solid, liquid, or gas.
 - (d) Determine the work per unit mass done in the process.
 - (e) Give an accurate sketch of the process in the $P - v$, $T - v$, and $P - T$ planes, including the vapor dome and critical point.
4. (50) N_2 is initially at $T_1 = 100 \text{ K}$, $P_1 = 100 \text{ kPa}$. It is isothermally compressed to $P_2 = 600 \text{ kPa}$. It is then isochorically decompressed to $P_3 = 100 \text{ kPa}$. It is then isobarically expanded to its initial state of $P_4 = P_1 = 100 \text{ kPa}$, $T_4 = T_1 = 100 \text{ K}$.
 - (a) Determine T_3 and the net work per unit mass of the cycle under the assumption that the ideal gas equation of state is valid for the entire cycle.
 - (b) Determine T_3 and the net work per unit mass of the cycle under the assumption that the N_2 tables give the equation of state for the entire cycle.
 - (c) Give an accurate sketch of the process in the $P - v$, $T - v$, and $P - T$ planes, including the vapor dome and critical point.