NAME:
AME 20231, Thermodynamics
Examination 1
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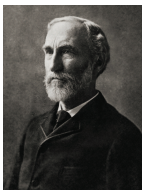

"Suppose the body to change its state, the points associated with the states through which the body passes will form a line, which we may call the *path* of the body."
Transactions of the Connecticut Academy, II., pp. 309-342, April-May 1873.

Josiah Williard Gibbs, b. 11 February 1839, d. 28 April 1903
Happy 181st Birthday, Prof. Gibbs!

1. (10) A box with $V = 1$ m^3 contains an ideal gas at $P = 1$ Pa and $T = 100$ K. Determine the number of moles in the box.

2. (10) A two-phase liquid-vapor mixture of H_2O at $v = 0.013$ m^3/kg and $T = 100°$C is heated isochorically until it is a single phase. Determine the final temperature and pressure of the H_2O. Determine if the final state is solid, liquid, or gas. Sketch the process in the $T - v$ plane.

3. (20) N_2 is at $P = 2121$ kPa, $T = 140$ K.

   (a) Find v with the ideal gas law.

   (b) Find v with the superheated nitrogen tables.

   (c) Find v with the compressibility chart, Fig. D.1.

   (d) Give an accurate sketch of the actual state of the N_2 in the $P-v$, $T-v$, and $P-T$ planes. The state should be properly placed relative to the vapor domes and critical points, which should also be part of the sketch.

4. (30) An ideal gas of mass m and gas constant R at pressure P_1 and temperature T_1 is compressed in an isochoric process until $T_2 = 2T_1$. The gas is isothermally expanded back to $P_3 = P_1$. The gas then undergoes an isobaric process to return to P_1 and T_1.

   (a) Find P_2 in terms of P_1, T_1, m, and R.

   (b) Find the work of each process in the cycle, ${}_1W_2$, ${}_2W_3$, and ${}_3W_1$ and W_{cycle} in terms of P_1, T_1, m, and R.

   (c) Sketch the cycle in the $P - v$ plane.

5. (30) A fixed mass, $m = 10$ kg, of H_2O is initially at $P = 100$ kPa, $x = 0.4$. It undergoes a two-step process. The first step is an isobaric heating until $T = 200°$C. The second step is an isothermal compression until $P = 500$ kPa.

   (a) Find v at the end of the isobaric heating.

   (b) Find the total work in the two-step process.

   (c) Sketch the two-step process, including the vapor domes and saturation lines, in the $T-v$, $P-v$, and $P-T$ planes.