NAME:
AME 20231
Thermodynamics
Examination 1
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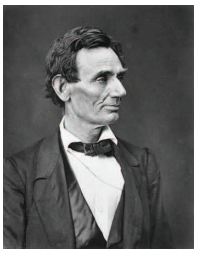

"The advantageous use of Steam-power is, unquestionably, a modern discovery.
And yet, as much as two thousand years ago the power of steam was not only observed,
but an ingenius toy was actually made and put in motion by it, at Alexandria in Egypt."

Abraham Lincoln, 6 April 1858
Bloomington, Illinois

Happy 201st Birthday!

1. (20) Diatomic nitrogen, N_2, exists at $T = 65.9\ K$, $v = 0.4\ m^3/kg$. Find the pressure.

2. (40) A mass, 10 kg, of H_2O initially at $T_1 = 30\ ^\circ C$, $v_1 = 0.001080\ m^3/kg$ is heated isochorically to state 2 where $T_2 = 140\ ^\circ C$. It then undergoes an isobaric process to state 3 where $T_3 = 250\ ^\circ C$.

   (a) Find the final specific volume.

   (b) Accurately sketch the total process in the $P-v$, $T-v$, and $P-T$ planes. Label each state in your sketch giving numerical values for P, T, v. Include the vapor dome in its correct position.

   (c) Find the work done in the total process.

3. (40) A mass of 0.01 kg of helium at $P_1 = 100\ kPa$, $T_1 = 300\ K$ exists inside of the piston-cylinder arrangement of Fig. 1. The piston has a cross-sectional

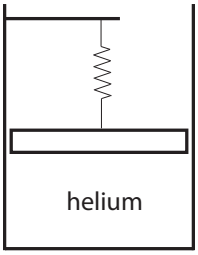

Figure 1: Piston-cylinder arrangement.

   area of $A = 0.2\ m^2$. The helium is heated until $T_2 = 2000\ K$. The motion of the piston is resisted by a linear spring. The spring exerts no force at state 1, and has a spring constant of 1000 kN/m.

   (a) Find the final pressure.

   (b) Find the total work done.