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 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.