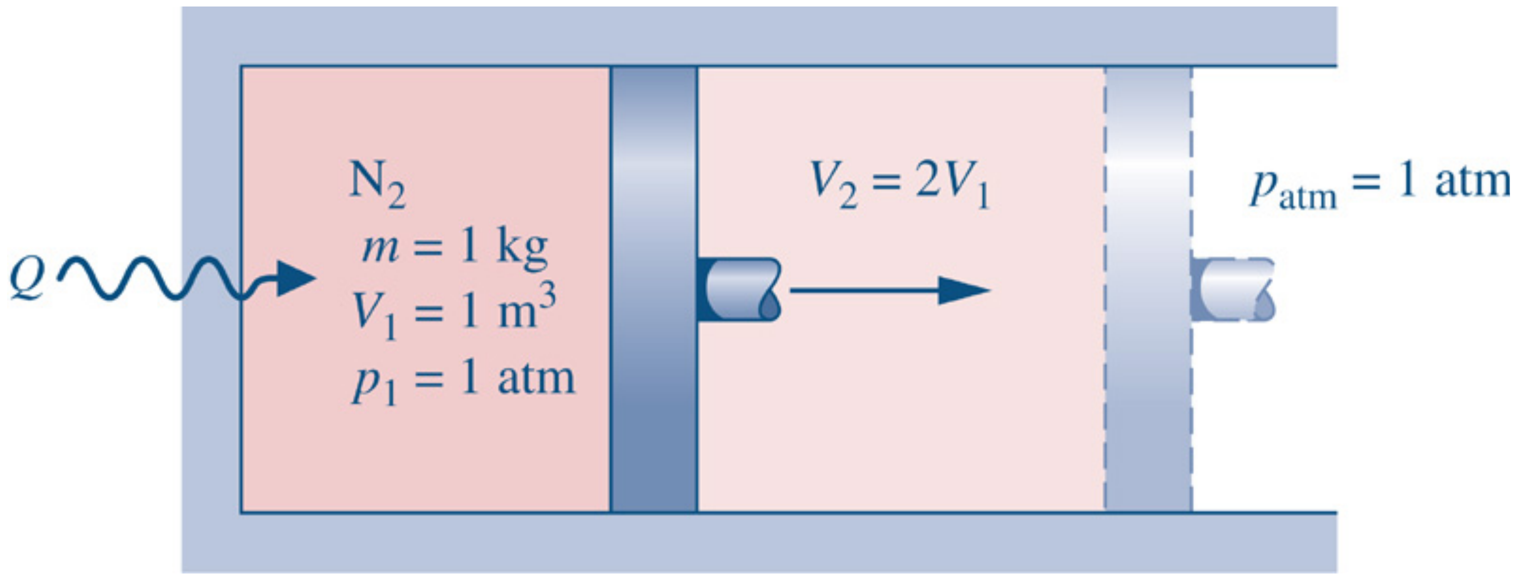
Consider the figure below of a perfect gas situation. One kilogram of nitrogen fills the cylinder of a piston- cylinder assembly. There is no friction between the piston and the cylinder walls, and the surroundings are at 1 atm. The initial volume and pressure in the cylinder are 1 m^3 and 1 atm, respectively. Heat transfer to the nitrogen occurs until the volume is doubled. (1 atm = 1.01325 bar; 1 bar = 10^5 N/m^2)

a) Determine the work for the process, in kJ.
b) Determine the heat transfer for the process, in kJ, assuming the specific heat (0.742 kJ/(kgK) is constant. Recall: $\underline{R}$ = 8.314kJ/(kmol K); M_{N2} = 28.01kg/kmol



Molecular weight of N_2 gas is M_{N2} = 28.01kg/kmol
R = R(universal constant)/M (Molecular weight) = 8.314/28.01 = .2968 kJ/(kg K)
PV = mRT (Know P_1, V_1, m_1, R) Solve for T_1 = 341.4K
PV = mRT (Know P_2, V_2, m_2, R) Solve for T_2 (But P_2=P_1, V_2 = $2V_1$), therefore T_2 = $2*T_1$=682.8K

$Q = m(u_2-u_1) + W$

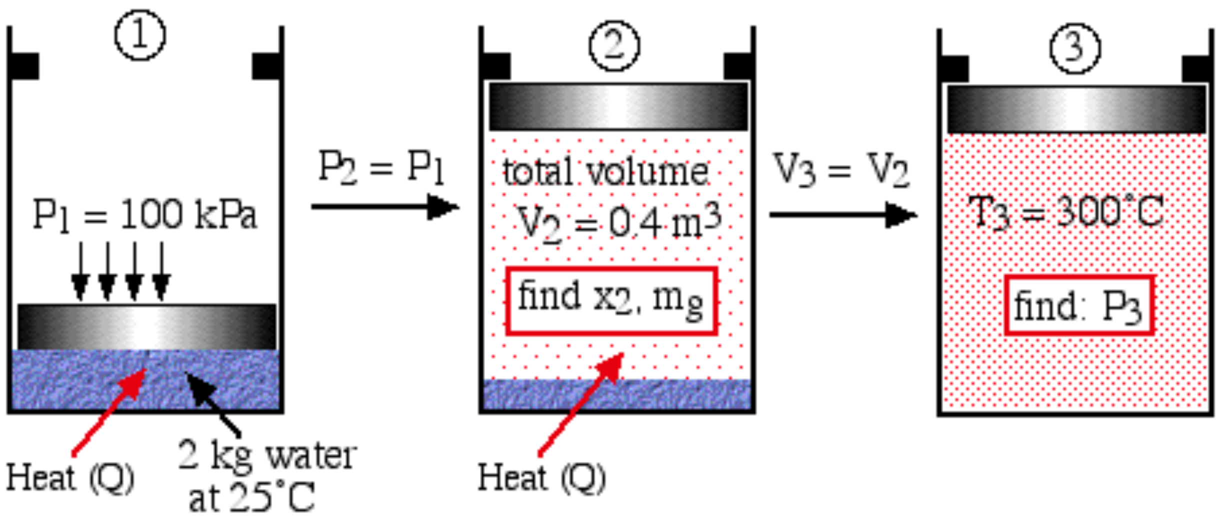
$du/dT = c_v$ Or $(u_2-u_1) = c_v (T_2-T_1)$ = .742(341.4K)= 253.32 kJ/kg

Q = 1kg(253.32kJ/kg) + $1.01325x10^5$ $N/m^2(2m^3-1m^3)(1kJ/(10^3 N/m^2))$ = 354.6 kJ

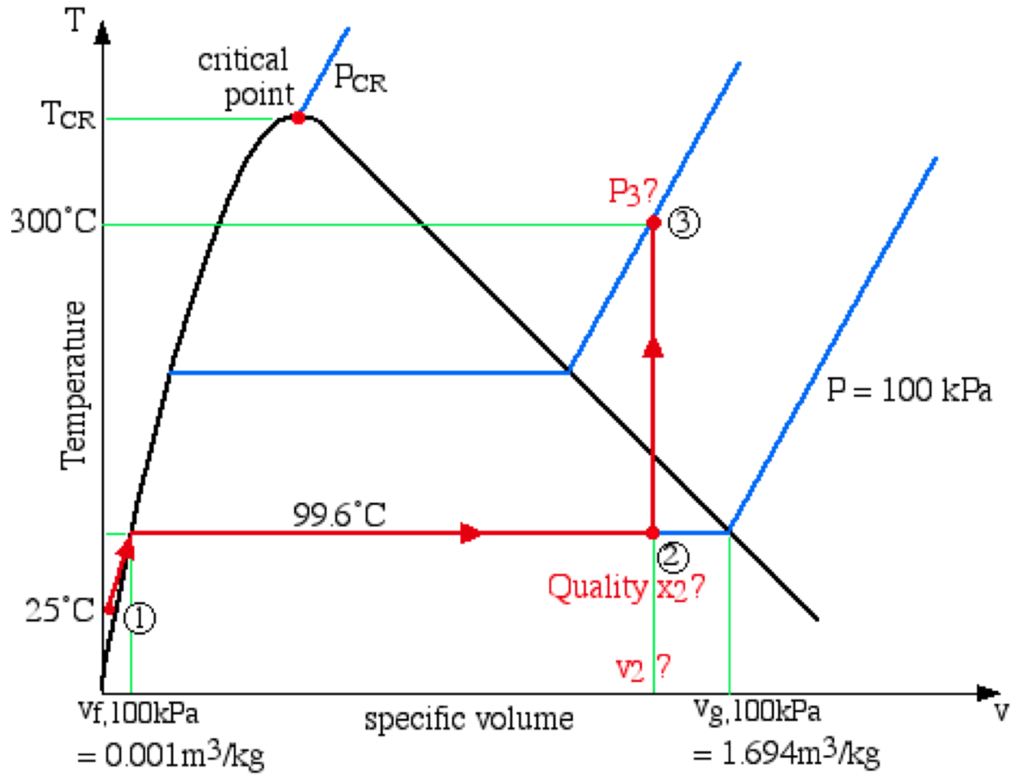
Two kilograms of water at 25°C are placed in a piston cylinder device under 100 kPa absolute pressure as shown in the diagram (State(1)). Heat is added to the water at constant pressure until the piston reaches the stops at a total volume of 0.4 m^3 (State (2)). More heat is then added at constant volume until the temperature of the water reaches 300°C (State (3)).

i) Draw a P-v and a T-v diagram of the states and processes of the problem and include all the relevant information on the diagram. In this case there are three states and two processes (state 1 to state 2 and state 2 to state 3). The diagrams do not have to be drawn to scale.

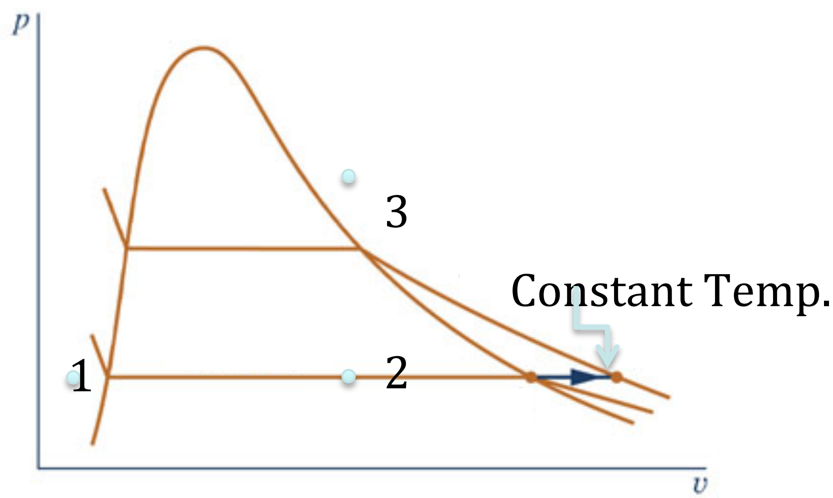
ii) Determine the quality (x) of the fluid and the mass of the vapor at state (2). (Schematic is not necessarily to scale.) Calculate the specific volume, specific internal energy, and specific enthalpy of the state.



i) Draw a P-v and a T-v diagram of the states and processes of the problem and include all the relevant information on the diagram. In this case there are three states and two processes (state 1 to state 2 and state 2 to state 3). The diagrams do not have to be drawn to scale.



It is not known where quality x2 is,
just somewhere on the horizontal line in the wet region.
P_{CR} line is not necessary, nor are the blue lines necessary.



i) Determine the quality (x) of the fluid and the mass of the vapor at state (2). (Schematic is not necessarily to scale.) Calculate the specific volume, specific internal energy, and specific enthalpy of the state.

$$v = v_f + x(v_g - v_f) = \frac{V}{m} = \frac{0.4}{2} = 0.2\ kg$$

$$x = \frac{v - v_f}{(v_g - v_f)} = \frac{.2 - .0010432}{(1.694 - .0010432)} = .117$$

$u = u_f + x(u_g - u_f) = 417.36 + .117(2506.1\text{-}417.36) = 661.74$
$h = h_f + x(h_g - h_f) = 417.46 + .117(2675.5\text{-}417.46) = 681.65$

$$x = \frac{v - v_f}{(v_g - v_f)} = \frac{.2 - .0010432}{(1.694 - .0010432)} = .117$$

mass of vapor = x (mass) = .117 * 2kg = .234 kg