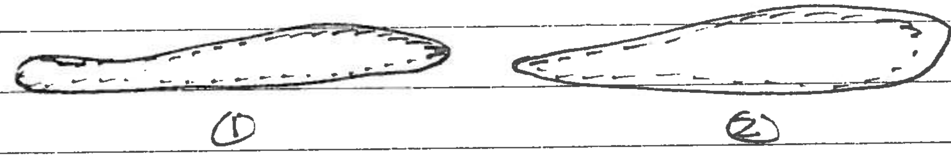
quiz 2 thermo solutions

$\boxed{T1}$

a)

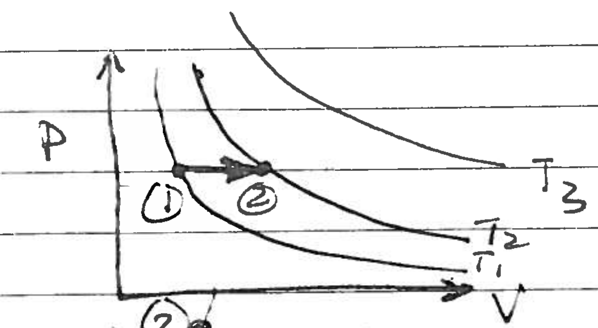


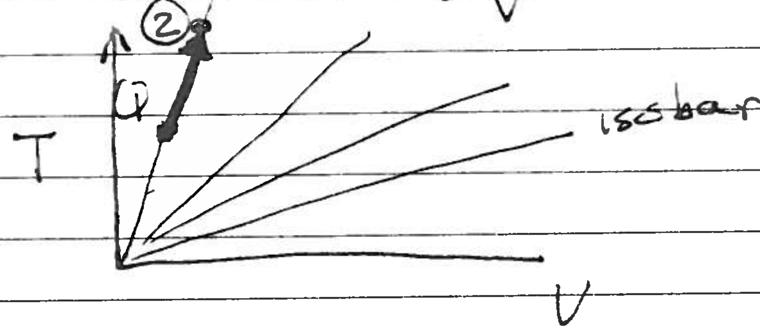
model as ideal gas, $R = 0.287 \frac{kJ}{kg\cdot k}$

$C_p = 1.004$ kJ/kg·k

$C_v = 0.717$ KJ/kg-k

b)





c) $dU = C_v dT$ for the ideal gas, assume const C_v (value given),

$$U_2 - U_1 = (0.5\ kg)(0.717 \frac{kJ}{kg\cdot k})(75\ k)$$

$$= \underline{26.9\ kJ}$$

d) This is a constant pressure process, so we can use $m C_p \Delta T = Q$

$$Q = 0.5(1.004)(75) = \underline{\underline{37.65\ kJ}}$$

e) $W = Q - \Delta U = m(C_p - C_v)\Delta T = \underline{10.8\ kJ}$

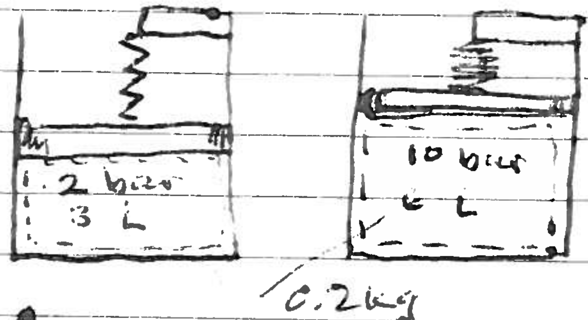
Alternately, we can get $W = \int P dV = P\Delta V$

$= P\left(\frac{mRT_2}{P_2} - \frac{mRT_1}{P_1}\right) = mR(T_2 - T_1)$ which is the same as above

quiz 2 thermo solutions

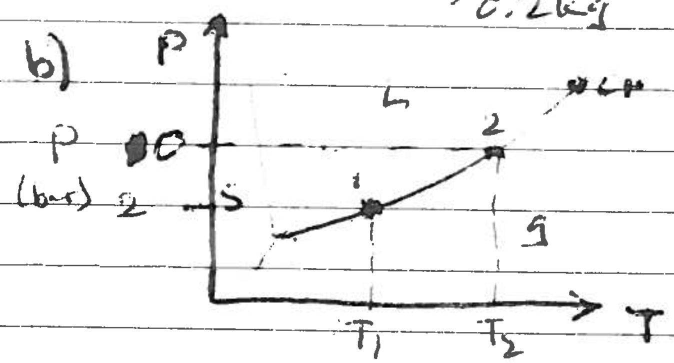
$\boxed{T2}$

a)



model as steam using steam tables in formula book

b)



$$v_1 = \frac{.003\ m^3}{.2\ kg} = .015\ m^3/kg$$

at 2 bar $v_f = .001061\ m^3/kg < v_1$

$v_g = 0.89\ \frac{m^3}{kg} > v_1$

$\therefore T_1 = 120.21\,^\circ C$

$$v_2 = \frac{.006\ m^3}{.2\ kg} = .030\ m^3/kg$$

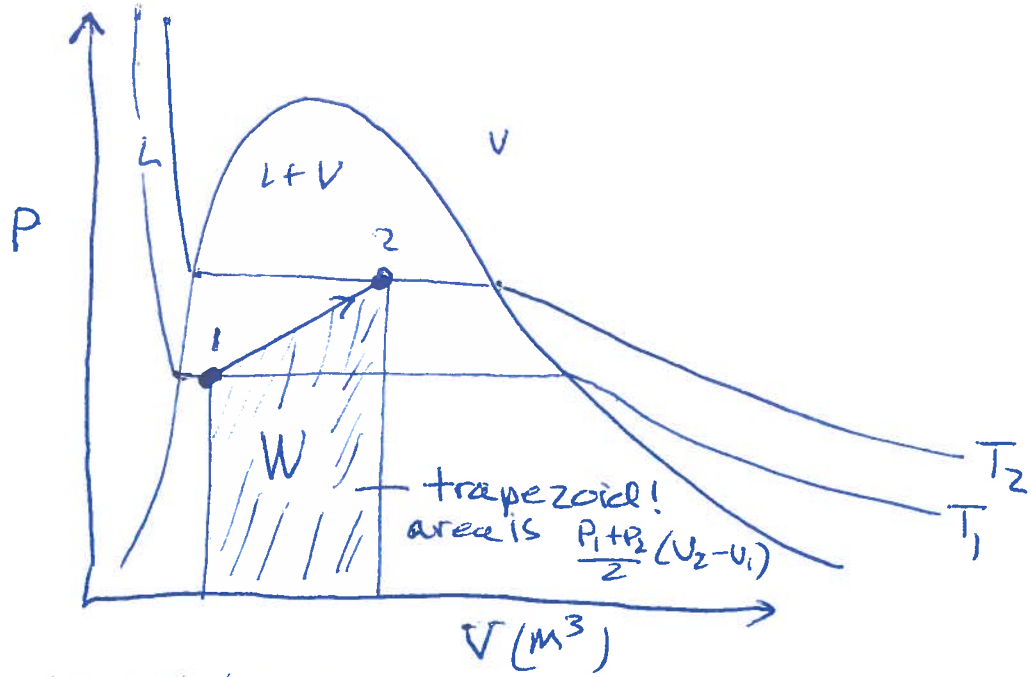
at 10 bar $v_f = .001127\ \frac{m^3}{kg} < v_2$

$v_g = 0.19\ \frac{m^3}{kg} > v_2$

By checking that v_1 and v_2 are both between the saturated liquid and vapor values, I can be sure that 1, 2 are on the saturated steam line

$$\boxed{\begin{aligned} T_1 &= 120.21\,^\circ C \\ T_2 &= 179.89\,^\circ C \end{aligned}}$$

c)



$$W = (V_2 - V_1)\left(\frac{P_1+P_2}{2}\right) = (3\ \text{L})(6\ \text{bar}) = 18\ \text{L-bar} = \underline{1.8\ \text{kJ}}$$

d) $v_1 = v_f + x_1(v_g - v_f) \Rightarrow x_1 = \frac{v_1 - v_f}{v_g - v_f} = \frac{(0.015\ \frac{m^3}{kg} - .001061)}{(0.89 - .001061)}$

$$\underline{x_1 = 0.01568}$$

$$x_2 = \frac{v_2 - v_f}{v_g - v_f} = \frac{.03 - .001127}{.19 - .001127} = \underline{x_2 = 0.15287}$$

Use these values of x_1, x_2 to get the energy:

$u_1 = u_{f_1} + x_1(u_{g_1} - u_{f_1}) = 504.5 + (.01568)(2529.1 - 504.5) = 536.24\ \frac{kJ}{kg}$

$u_2 = u_{f_2} + x_2(u_{g_2} - u_{f_2}) = 761.6 + (.15287)(2582.8 - 761.6) = 1040.01\ \frac{kJ}{kg}$

$$U_2 - U_1 = (.2\ \text{kg})(1040.01 - 536.2)$$
$$= \underline{\underline{100.7\ \text{kJ}}}$$

e) $U_2 - U_1 = Q - W$ (First Law!)

$$\underline{Q = 100.7 + 1.8 = 102.5\ \text{kJ}}$$