

Question 1

Water is contained in a piston/cylinder arrangement at 2000 kPa, 300°C with a massless piston against the stops, at which point $V = 0.1 \text{ m}^3$. The piston/cylinder device is connected by an open valve to an air line at 500 kPa and 100°C, as shown in Figure Q1. The water undergoes the processes below:

Process 1-2: heat is removed from the cylinder until the piston is at the onset of movement

Process 2-3: heat continues to be removed and the piston moves downwards until the final temperature of the water is $T_3 = 100^\circ\text{C}$

- Determine the state of the water when the piston begins to move (e.g. superheated vapor, saturated mixture, compressed liquid?) (4)
- What is the final pressure of the water? (4)
- Determine the Boundary Work performed in kJ (4)
- Determine the overall heat transfer of the system in kJ (4)
- Draw the processes on a P-v diagram. Do not worry about an exact representation of the Saturated "Dome" or exact locations of the P's and v's. Marks will be allocated for identifying the correct states & processes. (4)

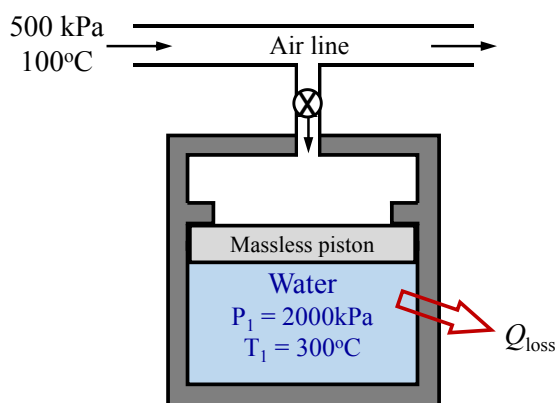


Figure Q1

Just in case: below are compressed liquid entries for water

TABLE B.1.4
Compressed Liquid Water

Temp. (°C)	v (m ³ /kg)	u (kJ/kg)	h (kJ/kg)	s (kJ/kg-K)	v (m ³ /kg)	u (kJ/kg)	h (kJ/kg)	s (kJ/kg-K)
	500 kPa (151.86°C)				2000 kPa (212.42°C)			
Sat.	0.001093	639.66	640.21	1.8606	0.001177	906.42	908.77	2.4473
0.01	0.000999	0.01	0.51	0.0000	0.000999	0.03	2.03	0.0001
20	0.001002	83.91	84.41	0.2965	0.001001	83.82	85.82	.2962
40	0.001008	167.47	167.98	0.5722	0.001007	167.29	169.30	.5716
60	0.001017	251.00	251.51	0.8308	0.001016	250.73	252.77	.8300
80	0.001029	334.73	335.24	1.0749	0.001028	334.38	336.44	1.0739
100	0.001043	418.80	419.32	1.3065	0.001043	418.36	420.45	1.3053
120	0.001060	503.37	503.90	1.5273	0.001059	502.84	504.96	1.5259
140	0.001080	588.66	589.20	1.7389	0.001079	588.02	590.18	1.7373
160	—	—	—	—	0.001101	674.14	676.34	1.9410
180	—	—	—	—	0.001127	761.46	763.71	2.1382
200	—	—	—	—	0.001156	850.30	852.61	2.3301

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