1. A system with two-inlets and insulated all the way as shown in figure 1, the temperature of inlet 1 is superheated water vapor at $T_{i,1}=160^0C$, mass flow rate $M_{i,1}=1Kg/min$, the temperature of inlet 2 is saturated water vapor at $T_{i,2}=100^0C$, mass flow rate $M_{i,2}=2Kg/min$. At initial state, the system is vacuum and valves are closed, when the two valves are opened simultaneously, we found the system pressure is 1.5 bar after 1 min, the valves are then closed again very quickly. Please identify the system final state (Saturated? Superheated? or Compressed?) (10%)? And system final temperature T_2 (10%).

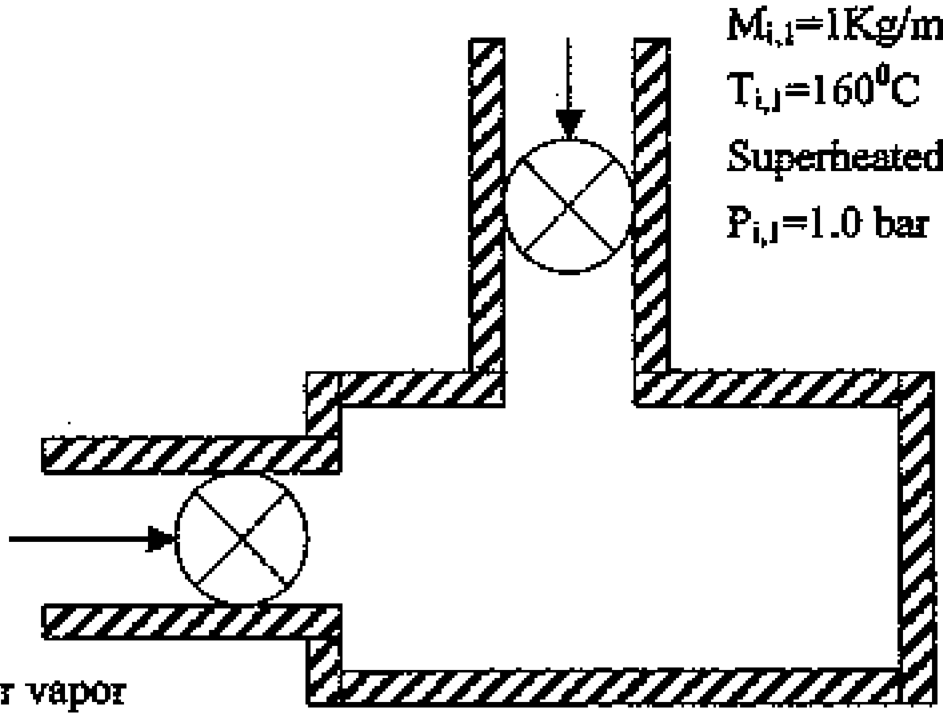

Figure 1

2. Given a Van Der Waals Gas, which is $(P+\frac{a}{V^2})(V-b)=RT$, please solve for a, b, in terms of (R, T_C, P_C), where R is gas constant, T_C and P_C represented the critical temperature and critical pressure of the gas. (20%)
3. Water vapor enters the turbine at 0.8Mpa，400 ^0C，and the outlet from the turbine is at 0.2Mpa, 200 ^0C. During this process, there is heat exchange between turbine and its environments, assume the environmental temperature is 25 ^0C, and 0.3Kg/s of vapor could generate 100KW for this turbine machine. According to these data, do you think it violate the second law of thermodynamics? (20%)

Superheated Water Vapor:

0.8Mpa	400 ^0C	hg=3267.1KJ/Kg	Sg=7.5716KJ/Kg,°K
0.2Mpa	200 ^0C	hg=2870.5KJ/Kg	Sg=7.5066KJ/Kg,°K

Steam Table for Properties of Saturated Water (Liquid-Vapor)

Temp. (°C)	Pressure (bars)	Internal Energy (KJ/Kg)		Enthalpy (KJ/Kg)		Entropy (KJ/Kg, °K)	
		Sat. Liquid Uf	Sat. Vapor Ug.	Sat. Liquid hf	Sat. Vapor hg	Sat. Liquid Sf	Sat. Vapor Sg
50	0.1235	209.32	2443.5	209.33	2952.1	0.7038	8.0763
55	0.1576	230.21	2450.1	230.23	2600.9	0.7679	7.9913
60	0.1994	251.11	2456.6	251.13	2609.6	0.8312	7.9096
65	0.2503	272.02	2463.1	272.06	2618.3	0.8935	7.8310
70	0.3119	292.95	2469.9	292.98	2626.8	0.9539	7.7553
75	0.3858	313.90	2475.9	313.93	2635.3	1.0155	7.6824
80	0.4739	334.86	2482.2	334.91	2643.7	1.0753	7.6122
85	0.5783	355.84	2488.4	355.90	2615.9	1.1343	7.5445
90	0.7014	376.85	2494.5	376.92	2660.1	1.1925	7.4791
95	0.8455	397.88	2500.6	397.96	2668.1	1.25	7.4159
100	1.014	418.94	2506.5	419.04	2676.1	1.3069	7.3549
110	1.433	461.14	2518.1	461.3	2691.5	1.4185	7.2387
120	1.985	503.5	2529.3	503.71	2706.3	1.5276	7.1296
130	2.701	546.02	2539.9	546.31	2720.5	1.6344	7.0269
140	3.613	588.74	2550.0	589.13	2733.9	1.7391	6.9299
150	4.758	631.68	2559.5	632.2	2746.5	1.8418	6.8379
160	6.178	674.86	2568.4	675.55	2758.1	1.9427	6.7502
170	7.917	718.33	2576.5	719.21	2768.7	2.0419	6.6663
180	10.02	762.09	2583.7	763.22	2778.2	2.1396	6.5857

Properties of Superheated Water Vapor

T (^{0}C)	u (KJ/Kg)	h (KJ/Kg)	S (KJ/Kg, ^{0}K)
P=1.0bar=0.1Mpa (Tsat=99.63^{0}C)			
Sat.	2506.1	2676.1	7.3549
100	2506.7	2676.2	7.3614
120	2537.3	2716.02	7.4560
160	2597.8	2795.66	7.6451
200	2658.1	2875.3	7.8343
240	2720.06	2955.88	7.9761
280	2782.02	3036.46	8.1180
320	2843.98	3117.04	8.2560
360	2905.94	3197.62	8.4017
400	2967.9	3278.2	8.5435

T (^{0}C)	u (KJ/Kg)	h (KJ/Kg)	S (KJ/Kg, ^{0}K)
P=1.5bar=0.15Mpa (Tsat=111.37^{0}C)			
Sat.	2519.7	2693.6.	7.2233
120	2533.3	2711.0	7.2642
160	2595.2	2792.0	7.4536
200	2656.	2873	7.6430
220	2687.1	2908.4	7.7142
240	2718.2	2943.8	7.7854
280	2780.4	3014.6	7.9278
320	2842.6	3085.4	8.0902
360	2904.8	3156.2	8.2126
400	2967.1	3277	8.355

4. Give the brief description of the Kelvin-Planck Statement (5%) and Clausius Statement (5%) and explain what is the inequality of Clausius (or write down the equation) (5%)

5. Please draw the T-S diagram for the ideal Reheat Rankine Cycle (5%) and explain why it is necessary since there is very little gain in efficiency from reheating the steam. (5%)

6. (a) Please prove the enthalpy change (Δh) is only function of the temperature, and nothing to do with the volume change or pressure change for an ideal gas with constant heat capacity Cp. (10%)

(b) If there is a state equation $P(V-b)=RT$, where b is constant and R is gas constant, the heat capacity of the gas is constant too, Cp. Please calculate the enthalpy change (Δh) from state 1 (T_1, P_1) to state 2 (T_2, P_2) (5%)