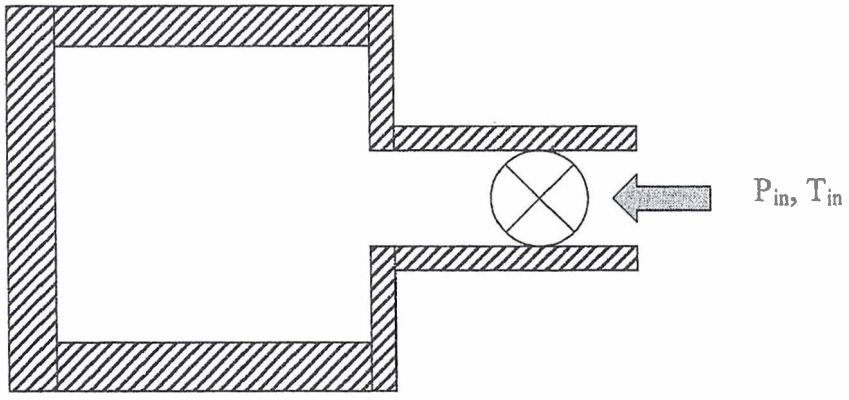
國　立　清　華　大　學　命　題　紙

95 學年度 工程與系統科學 系（所） 71 組碩士班入學考試

科目 熱力學 科目代碼 3402 共 4 頁第 1 頁 *請在【答案卷卡】內作答

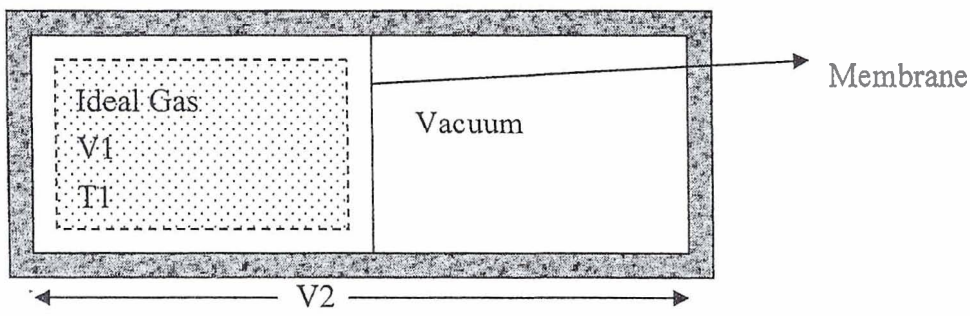
1. A tank of volume V is to be filled with an ideal gas. Initially the tank is at P_1 and T_1. the port is regulated with a valve, and the port properties are constant at T_{in}. The tank is well insulated so the process is adiabatic. If the final pressure of the tank is P_2, determine the final temperature of the tank T_2 as function of P_2, P_1, κ, T_{in} and T_1. For ideal gas $\kappa=C_p/C_v$, where C_p is the heat capacity for gas at constant pressure and C_v is the heat capacity for gas at constant volume. (15%)



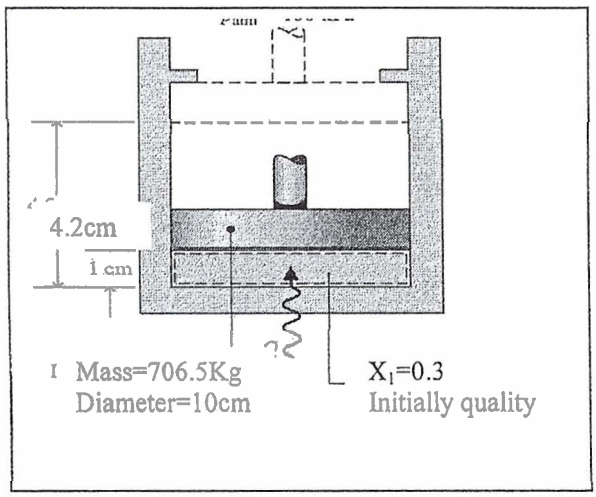
2. Explain
   (a) What is the closed system (2%)
   (b) What is the isolated system (2%)
   (c) What is the isothermal process (2%)
   (d) What is isochoric process (2%)
   (e) What is the adiabatic process (3%)
   (f) What is isentropic process (4%)

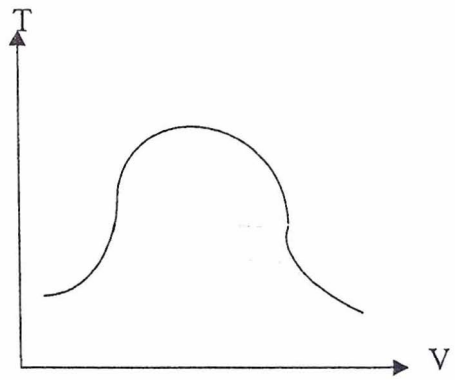
3. To increase the thermal efficiency of a reversible power cycle operating between reservoirs at T_H and T_C. Would you increase T_H while keeping T_C constant, or decrease T_C while keeping T_H constant? Why? And prove it. Are there any natural limits on the increase in thermal efficiency that might be achieved by such means? (15%)

4. In the following figure 1, shows a gas separated from vacuum by a membrane (state 1: v1, T1). The tank is fully isolated with fiber glass. Then let membrane rupture and the gas fill the entire volume, (state 2: V2), all the friction loss can be neglected, gas can be assumed to be an ideal gas, no flow work:
   (a) Is there any mechanical work? If there is work, write down the work equation as function of (T, V1, V2), if there is no mechanical work, explain why? (2%)
   (b) What is the internal energy change? (3%)
   (c) What is the temperature T2 at state 2? And why (5%)
   (d) What is the entropy change? (5%)
   (e) Draw the P-V diagram from state 1 to state2 (5%)



5. A two-phase liquid-vapor mixture of H_2O with an initial quality of 30% is contained in a piston-cylinder assembly as shown in following figure. The mass of the piston is 706.5Kg, and its diameter is 10cm. The atmospheric pressure of the surroundings is 1 bar. The initial and the final positions of the piston are shown on the diagram. As the water is start to heat (state 1), the pressure inside the cylinder remains constant until the piston hits the stops (state 2). Heat transfer to the water continues until its pressure is 15 bar (state 3). Friction between the piston and the cylinder wall is negligible.
   (a) Sketch the T-V diagram from state 1 to state 3 (6%), and mark the value of (P, T) on each state (6%)
   (b) Determine the specific volume (m^3/Kg) of state 1 (2%); the specific volume (m^3/Kg) of state 2 (2%) and the specific volume (m^3/Kg) of state 3 (2%);
   (c) Determine the total mass of water (2%) in Kg
   (d) Determine the work (KJ) from the state 1 to 2 (2%) and from state 2 to 3 (3%) in KJ/Kg
   (e) Determine the internal energy of state 1 (3%) and the state 3 (3%) in KJ
   (f) Determine the total amount of heat transfer (4%), in KJ. let g = 10m/s^2





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科目 熱力學 科目代碼 3402 共 4 頁第 3 頁 *請在【答案卷卡】內作答

State (Unit)	T (^{0}C)	P (Mpa)	V_f (m^3/Kg)	V_g (m^3/Kg)	U_f (KJ/Kg)	U_g (KJ/Kg)	h_f (KJ/Kg)	h_g (KJ/Kg)	S_f (KJ/Kg,^{0}K)	S_g (KJ/Kg,^{0}K)
Superheat	380	3.8		0.0741		2877.3		3158		6.7159
Superheat	400	4.0		0.07341		2919.6		3213.6		6.769
Saturated	40	7.38×10^{-3}	0.001008	19.52	167.56	2430.1	167.57	2574.3	0.5725	8.257
Saturated	45	9.59×10^{-3}	0.001010	15.26	188.48	2436.8	188.45	2583.2	0.6387	8.1648
Saturated	50	12.34×10^{-3}	0.001012	12.03	209.32	2443.5	209.33	2592.1	0.7038	8.0763
Saturated	55	15.75×10^{-3}	0.001015	9.568	230.21	2450.1	230.23	2600.9	0.7679	7.9913
Saturated	60	19.94×10^{-3}	0.001017	7.670	251.11	2456.6	251.13	2609.6	0.8312	7.9096
Saturated	65	25.03×10^{-3}	0.001020	6.197	272.02	2463.1	272.06	2618.3	0.8935	7.8310
Saturated	70	31.19×10^{-3}	0.001023	5.042	292.95	2469.6	292.98	2626.8	0.9549	7.7553
Saturated	75	38.58×10^{-3}	0.001026	4.131	313.9	2475.9	313.93	2635.3	1.0155	7.6824
Saturated	80	47.39×10^{-3}	0.001029	3.407	334.86	2482.2	334.91	2643.7	1.0753	7.6122
Saturated	85	57.83×10^{-3}	0.001033	2.828	355.84	2488.4	355.9	2651.9	1.1343	7.5445
Saturated	90	70.14×10^{-3}	0.001036	2.361	376.85	2494.5	376.92	2660.1	1.1925	7.4791
Saturated	95	84.55×10^{-3}	0.001040	1.982	397.88	2500.6	397.96	2668.1	1.2500	7.4159
Saturated	100	0.10135	0.001044	1.6729	418.94	2506.5	419.04	2676.1	1.3069	7.3549
Saturated	105	0.12	0.001048	1.4194	440.02	2512.4	440.15	2683.8	1.3630	7.2958
Saturated	110	0.14	0.001052	1.2102	461.14	2518.1	461.3	2691.5	1.4185	7.2387
Saturated	115	0.169	0.001056	1.0366	482.3	2523.7	482.48	2699.0	1.4734	7.1833
Saturated	120	0.198	0.001060	0.8919	503.5	2529.3	503.71	2706.3	1.5276	7.1296
Saturated	130	0.271	0.001069	0.6685	546.02	2539.9	546.31	2720.5	1.6344	7.0269
Saturated	140	0.3613	0.001079	0.5089	588.74	2550.0	589.13	2733.9	1.7391	6.9299
Saturated	150	0.4758	0.001090	0.3928	631.68	2559.5	632.2	2746.5	1.8418	6.8379
Saturated	160	0.6178	0.001102	0.3071	674.86	2568.4	675.55	2758.1	1.9427	6.7502
Saturated	170	0.7917	0.001114	0.2428	718.33	2576.5	719.21	2768.7	2.0419	6.6663
Saturated	180	1.02	0.001127	0.1941	762.09	2583.7	763.22	2778.2	2.1396	6.5857
Saturated	190	1.254	0.001141	0.1565	806.19	2590.0	807.62	2786.4	2.2359	6.5079
Saturated	200	1.554	0.001156	0.1274	850.65	2595.3	852.45	2793.2	2.3309	6.4323
Subcooled	40	5	0.001		166.95		171.97		0.5705	
Subcooled	60	5	0.00101		250.23		255.3		0.8285	
Superheated	200	1		0.2060		2621.9		2827.9		6.694
Superheated	240	1		0.2275		2692.9		2920.4		6.8817
Superheated	280	1		0.2480		2760.2		3008.2		7.0465
Superheated	320	1		0.2678		2826.1		3093.9		7.1962
Superheated	360	1		0.2873		2891.6		3178.9		7.3349
Superheated	400	1		0.3066		2957.3		3263.9		7.4651
Superheated	440	1		0.3257		3023.6		3349.3		7.5883
Superheated	500	1		0.3541		3124.4		3478.5		7.7622
Superheated	540	1		0.3729		3192.6		3565.6		7.8720

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科目 熱力學 科目代碼 3402 共 4 頁第 4 頁 *請在【答案卷卡】內作答

State (Unit)	T (^{0}C)	P (Mpa)	V_f (m^3/Kg)	V_g (m^3/Kg)	U_f (KJ/Kg)	U_g (KJ/Kg)	h_f (KJ/Kg)	h_g (KJ/Kg)	S_f (KJ/Kg,^{0}K)	S_g (KJ/Kg,^{0}K)
Superheated	200	1.5		0.1325		2598.1		2796.8		6.4546
Superheated	240	1.5		0.1483		2676.9		2899.3		6.6628
Superheated	280	1.5		0.1627		2748.6		2992.7		6.8381
Superheated	320	1.5		0.1765		2817.1		3081.9		6.9938
Superheated	360	1.5		0.1899		2884.4		3169.2		7.1363
Superheated	400	1.5		0.2030		2951.3		3255.8		7.2690
Superheated	440	1.5		0.2160		3018.5		3342.5		7.3940
Superheated	500	1.5		0.2352		3120.3		3473.1		7.5698
Superheated	540	1.5		0.2478		3189.1		3560.9		7.6805
Superheated	600	1.5		0.2668		3293.9		3694.0		7.8385
Superheated	640	1.5		0.2793		3364.8		3783.8		7.9391
Superheated	240	2.0		0.1085		2659.6		2876.5		6.4952
Superheated	280	2.0		0.1200		2736.4		2976.4		6.6828
Superheated	320	2.0		0.1308		2807.9		3069.5		6.8452
Superheated	360	2.0		0.1411		2877.0		3159.3		6.9917
Superheated	400	2.0		0.1512		2945.2		3247.6		7.1271
Superheated	440	2.0		0.1611		3013.4		3335.5		7.2540
Superheated	500	2.0		0.1757		3116.2		3467.6		7.4317
Superheated	540	2.0		0.1853		3185.6		3556.1		7.5434
Superheated	600	2.0		0.1996		3290.9		3690.1		7.7024
Superheated	640	2.0		0.2091		3362.2		3780.4		7.8035
Superheated	240	3.0		0.0682		2619.7		2824.3		6.2265
Superheated	280	3.0		0.0771		2709.9		2941.3		6.4462
Superheated	320	3.0		0.0850		2788.4		3043.4		6.6245
Superheated	360	3.0		0.0923		2861.7		3138.7		6.7801
Superheated	400	3.0		0.0994		2932.8		3230.9		6.9212
Superheated	440	3.0		0.1062		3002.9		3321.5		7.0520
Superheated	500	3.0		0.1162		3108.0		3456.5		7.2338
Superheated	100	0.1		1.696		2506.7		2676.2		7.3614
Superheated	120	0.1		1.793		2537.3		2716.6		7.4668
Superheated	160	0.1		1.984		2597.8		2796.2		7.6597
Superheated	200	0.1		2.172		2658.1		2875.3		7.8343
Superheated	240	0.1		2.359		2718.5		2954.5		7.9949
Superheated	280	0.1		2.546		2779.6		3034.2		8.1445
Superheated	320	0.1		2.732		2841.5		3114.6		8.2849
Superheated	360	0.1		2.917		2904.2		3195.9		8.4175
Superheated	400	0.1		3.103		2967.9		3278.2		8.5435
Superheated	440	0.1		3.288		3032.6		3361.4		8.6636