

國立臺北科技大學
九十七學年度研究所碩士在職專班(含 EMBA)入學考試

能源與冷凍空調工程系碩士班
丙組：熱力學試題

填准考證號碼

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注意事項：

1. 本試題共【五】題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在試卷答案欄內，否則不予計分。

1. (40%) Answer the following problems
 - a. (10%) Is it possible to develop (a) an actual and (b) a reversible heat-engine cycle that is more efficient than a Carnot cycle operating between the same temperature limits? Explain.
 - b. (10%) Consider two identical rooms, one with a refrigerator in it and the other without one. If all the doors and windows are closed, will the room that contains the refrigerator be cooler or warmer than the other room? Why?
 - c. (10%) Does a heat engine that has a thermal efficiency of 100 percent necessarily violate (a) the first law and (b) the second law of thermodynamics? Explain.
 - d. (10%) What mechanism can cause the entropy of a closed system to change? Is it possible for the entropy change of a closed system to be zero during an irreversible process? How about the case of an open system? Explain.
2. (15%) A Carnot heat pump is to be used to heat a house and maintain it at 20°C in winter. On a day when the average outdoor temperature remains at about 2°C, the house is estimated to lose heat at a rate of 82000 kJ/h. If the heat pump consumes 8 kW of power while operating, determine (a) how long the heat pump ran on that day; (b) the total heating costs, assuming an average price of 2.5 NT\$/kWh for electricity; and (c) the heating cost for the same day if resistance heating is used instead of a heat pump.

3. (15%) A 50-kg copper block initially at 80°C is dropped into an insulated tank that contains 120 L of water at 25°C. Determine the final equilibrium temperature and the total entropy change for this process. ($C_{p, \text{water}} = 4.18 \text{ kJ/kgK}$, $C_{p, \text{copper}} = 0.386 \text{ kJ/kgK}$)
4. (15%) A supply of 40 kg of shrimp at 8°C contained in a box is to be frozen to -18°C in a freezer. Determine the amount of heat that needs to be removed. The latent heat of the shrimp is 277 kJ/kg and its specific heat is 3.62 kJ/kg°C above freezing and 1.89 kJ/kg°C below freezing. The container box is 1.2 kg and is made up of polyethylene, whose specific heat is 2.3 kJ/kg°C. Also, the freezing temperature of shrimp is -2.2°C.
5. (15%) Refrigerant-134a at 1MPa and 80°C is to be cooled to 1 MPa and 30°C in a condenser by air. The air enters at 100 kPa and 27°C with a volume flow rate of 800 m³/min and leaves at 95 kPa and 60°C. Determine the mass flow rate of the air and refrigerant. (Air: $C_p = 1.005 \text{ kJ/kg°C}$)

Saturated refrigerant-134a—Temperature table

Temp., T °C	Press., P _{sat} MPa	Specific volume, m ³ /kg		Internal energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/kg · K	
		Sat. liquid, v _f	Sat. vapor, v _g	Sat. liquid, u _f	Sat. vapor, u _g	Sat. liquid, h _f	Evap., h _{fg}	Sat. vapor, h _g	Sat. liquid, s _f	Sat. vapor, s _g
8	0.38756	0.0007884	0.0525	60.43	231.46	60.73	191.07	251.80	0.2354	0.9150
12	0.44294	0.0007971	0.0460	65.83	233.63	66.18	187.85	254.03	0.2545	0.9132
16	0.50416	0.0008062	0.0405	71.29	235.78	71.69	184.52	256.22	0.2735	0.9116
20	0.57160	0.0008157	0.0358	76.80	237.91	77.26	181.09	258.35	0.2924	0.9102
24	0.64566	0.0008257	0.0317	82.37	240.01	82.90	177.55	260.45	0.3113	0.9089
26	0.68530	0.0008309	0.0298	85.18	241.05	85.75	175.73	261.48	0.3208	0.9082
28	0.72675	0.0008362	0.0281	88.00	242.08	88.61	173.89	262.50	0.3302	0.9076
30	0.77006	0.0008417	0.0265	90.84	243.10	91.49	172.00	263.50	0.3396	0.9070
32	0.81528	0.0008473	0.0250	93.70	244.12	94.39	170.09	264.48	0.3490	0.9064
34	0.86247	0.0008530	0.0236	96.58	245.12	97.31	168.14	265.45	0.3584	0.9058
36	0.91168	0.0008590	0.0223	99.47	246.11	100.25	166.15	266.40	0.3678	0.9053
38	0.96298	0.0008651	0.0210	102.38	247.09	103.21	164.12	267.33	0.3772	0.9047
40	1.0164	0.0008714	0.0199	105.30	248.06	106.19	162.05	268.24	0.3866	0.9041
42	1.0720	0.0008780	0.0188	108.25	249.02	109.19	159.94	269.14	0.3960	0.9035
44	1.1299	0.0008847	0.0177	111.22	249.96	112.22	157.79	270.01	0.4054	0.9030
48	1.2526	0.0008989	0.0159	117.22	251.79	118.35	153.33	271.68	0.4243	0.9017
52	1.3851	0.0009142	0.0142	123.31	253.55	124.58	148.66	273.24	0.4432	0.9004
56	1.5278	0.0009308	0.0127	129.51	255.23	130.93	143.75	274.68	0.4622	0.8990
60	1.6813	0.0009488	0.0114	135.82	256.81	137.42	138.57	275.99	0.4814	0.8973
70	2.1162	0.0010027	0.0086	152.22	260.15	154.34	124.08	278.43	0.5302	0.8918
80	2.6324	0.0010766	0.0064	169.88	262.14	172.71	106.41	279.12	0.5814	0.8827
90	3.2435	0.0011949	0.0046	189.82	261.34	193.69	82.63	276.32	0.6380	0.8655
100	3.9742	0.0015443	0.0027	218.60	248.49	224.74	34.40	259.13	0.7196	0.8117

注意：背面尚有試題