國立中正大學 114 學年度碩士班招生考試試題

科目名稱：熱力學　　本科目共 2 頁　第 1 頁

系所組別：機械工程學系-丙組

1. (30%) Multiple Choice Questions: Choose the best answer for each question. Each question is worth 3 points.

   (1). A change in the state of gas during which the pressure of the gas remains constant is called change. (a) adiabatic (b) isothermal (c) isobaric (d) isochoric.

   (2). All natural processes are _____ (a) reversible (b) isothermal (c) irreversible (d) none of the above.

   (3). The adiabatic relation between pressure and temperature of gas is (a) $P^{\gamma-1}T^{\gamma} = \text{Constant}$ (b) $PV^{\gamma} = \text{Constant}$ (c) $P^{\gamma}T^{\gamma-1} = \text{Constant}$ (d) $T^{\gamma}/P^{\gamma-1} = \text{Constant}$.

   (4). The first law of thermodynamics is (a) PdV= RdT (b) C_p-C_v= R (c) $PV^{\gamma} = \text{Constant}$ (d) dQ= dU+dW.

   (5). Entropy is a (a) path function, intensive property (b) path function, extensive property (c) point function, intensive property (d) point function, extensive property.

   (6). For an irreversible process, (a) dS=dQ/T (b) dS>dQ/T (c) dS<dQ/T (d) none of the mentioned.

   (7). The entropy of an isolated system can never, (a) increase (b) decrease (c) be zero (d) none of the mentioned.

   (8). The temperature of an ideal gas increases from 20℃ to 40℃ while the pressure stays the same. What happens to the volume of the gas? (a) It doubles. (b) It quadruples. (c) It is cut to one-half. (d) It is cut to one-fourth. (e) It slightly increases.

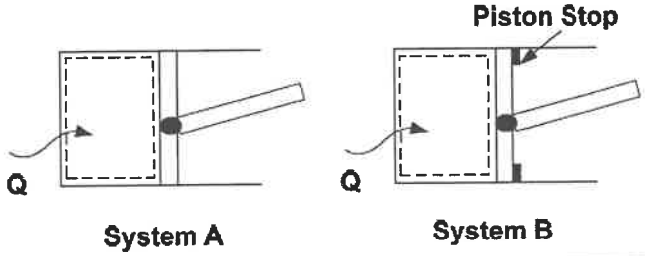
   (9). A sample of an ideal gas has an internal energy U and is then compressed to one-half of its original volume while the temperature stays the same. What is the new internal energy of the ideal gas in terms of U? (a) U (b) 1/2U (c) 1/4U (d) 2U (e) 4U.

   (10). Three containers filled with 1 kg of each: water, ice, and water vapor at the same temperature T = 0 ℃. Which of the following is true about the internal energy of the substances? (a) $U_{water} > U_{ice} > U_{vapor}$> (b) $U_{water} < U_{ice} > U_{vapor}$ (c) $U_{water} = U_{ice} = U_{vapor}$ (d) $U_{water} < U_{ice} < U_{vapor}$ (e) $U_{ice} < U_{water} < U_{vapor}$.

2. (20%) Consider two piston-cylinder devices shown below. In system A, heat is added, the piston is free to move, and it is found that the magnitude of work done is more than the magnitude of heat added. In system B, heat is added when the piston is resting against a set of stops; therefore, the piston cannot move. Assume that changes in kinetic and potential energy are negligible. You must provide justification with appropriate equation(s) to receive full credit.

   (1). What happens to internal energy when heat is added in system A? (increases; decreases; or remains the same ?) (10%)

   (2). What happens to internal energy when heat is added in system B? (increases; decreases; or remains the same ?) (10%)



3. (20%) A Carnot power cycle with the isothermal expansion occurring at 600 K and compression at 300 K. Determine
   (a) the thermal efficiency. (10%)
   (b) the thermal efficiency if the compression occurs at 400 K. (5%)
   (c) the thermal efficiency if the expansion occurs at 500 K. (5%)
4. (30%) A turbine is operated at a steady state with water vapor entering at 6 MPa, 600 °C and expanding to 10 kPa. The mass flow rate is 2 kg/s, and the power developed is 2626 kW. Stray heat transfer, kinetic, and potential energy effects are negligible. Determine
   (a) the isentropic turbine efficiency. (15%)
   (b) the rate of entropy production within the turbine, in kW/K. (15%)

Properties of superheated water vapor

T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K
	p = 40 bar = 4.0 MPa (T_{sat} = 250.4°C)				p = 60 bar = 6.0 MPa (T_{sat} = 275.64°C)			
Sat.	0.04978	2602.3	2801.4	6.0701	0.03244	2589.7	2784.3	5.8892
280	0.05546	2680.0	2901.8	6.2568	0.03317	2605.2	2804.2	5.9252
320	0.06199	2767.4	3015.4	6.4553	0.03876	2720.0	2952.6	6.1846
360	0.06788	2845.7	3117.2	6.6215	0.04331	2811.2	3071.1	6.3782
400	0.07341	2919.9	3213.6	6.7690	0.04739	2892.9	3177.2	6.5408
440	0.07872	2992.2	3307.1	6.9041	0.05122	2970.0	3277.3	6.6853
500	0.08643	3099.5	3445.3	7.0901	0.05665	3082.2	3422.2	6.8803
540	0.09145	3171.1	3536.9	7.2056	0.06015	3156.1	3517.0	6.9999
600	0.09885	3279.1	3674.4	7.3688	0.06525	3266.9	3658.4	7.1677
640	0.1037	3351.8	3766.6	7.4720	0.06859	3341.0	3752.6	7.2731
700	0.1110	3462.1	3905.9	7.6198	0.07352	3453.1	3894.1	7.4234
740	0.1157	3536.6	3999.6	7.7141	0.07677	3528.3	3989.2	7.5190

Properties of saturated water

Press. bar	Temp. °C	Specific Volume m³/kg		Internal Energy kJ/kg		Enthalpy kJ/kg			Entropy kJ/kg · K		Press. bar
		Sat. Liquid $v_f \times 10^3$	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	
0.04	28.96	1.0040	34.800	121.45	2415.2	121.46	2432.9	2554.4	0.4226	8.4746	0.04
0.06	36.16	1.0064	23.739	151.53	2425.0	151.53	2415.9	2567.4	0.5210	8.3304	0.06
0.08	41.51	1.0084	18.103	173.87	2432.2	173.88	2403.1	2577.0	0.5926	8.2287	0.08
0.10	45.81	1.0102	14.674	191.82	2437.9	191.83	2392.8	2584.7	0.6493	8.1502	0.10
0.20	60.06	1.0172	7.649	251.38	2456.7	251.40	2358.3	2609.7	0.8320	7.9085	0.20
0.30	69.10	1.0223	5.229	289.20	2468.4	289.23	2336.1	2625.3	0.9439	7.7686	0.30
0.40	75.87	1.0265	3.993	317.53	2477.0	317.58	2319.2	2636.8	1.0259	7.6700	0.40
0.50	81.33	1.0300	3.240	340.44	2483.9	340.49	2305.4	2645.9	1.0910	7.5939	0.50