題號：277

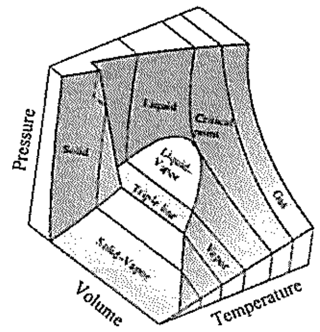
(1) Provide brief illustrations for the followings:

(a) Manometer, (5%)

(b) Enthalpy and entropy, (5%)

(c) Greenhouse effect and global warming, (5%)

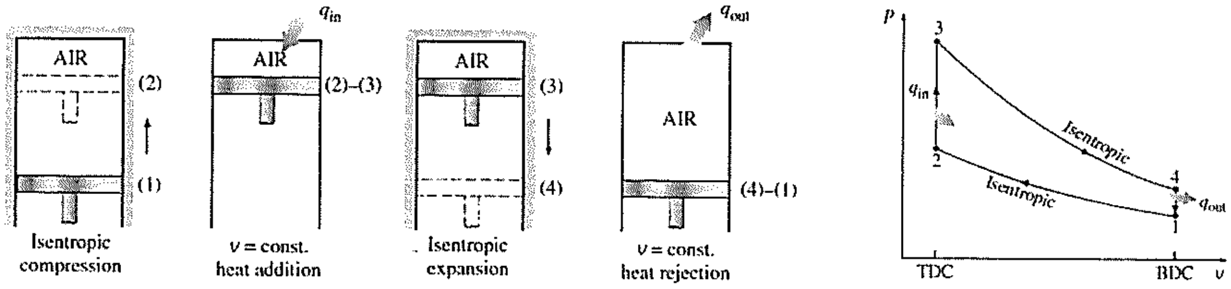
(d) The pressure-volume-temperature diagram of a substance shown below (5%)



(2) A 100 m^3 rigid tank initially contains a mixture of saturated vapor steam and saturated liquid water at 1,002,340 Pa (approximately 9.89 atm; 1 Pa = 1 N/m^2). Of the total mass, 20% is vapor. Saturated liquid only is bled slowly from the tank until the total mass in the tank drops to half of the initial total mass. During this process the temperature of the contents of the tank is kept constant by the transfer of heat. How much heat is transferred? Discuss the situation when the walls of the tank are thermal insulated. The information in the Steam Table shown below is helpful. (30%)

T C	P_{sat} kPa	v_f m3/kg	v_g m3/kg	v_{fg} m3/kg	h_f kJ/kg	h_g kJ/kg	h_{fg} kJ/kg	u_f kJ/kg	u_g kJ/kg	u_{fg} kJ/kg	s_f kJ/kg K	s_g kJ/kg K	s_{fg} kJ/kg K
170	791.870	0.001115	0.242662	0.241547	718.764	2767.22	2048.45	717.881	2575.06	1857.18	2.0392	6.6628	4.6236
172	830.875	0.001117	0.231834	0.230717	727.532	2769.15	2041.62	726.604	2576.52	1849.92	2.0588	6.6464	4.5876
174	871.384	0.001120	0.221580	0.220461	736.316	2771.03	2034.71	735.340	2577.95	1842.61	2.0782	6.6301	4.5518
176	913.436	0.001122	0.211865	0.210743	745.116	2772.87	2027.75	744.091	2579.34	1835.25	2.0976	6.6139	4.5162
178	957.072	0.001125	0.202656	0.201531	753.931	2774.65	2020.72	752.855	2580.69	1827.84	2.1170	6.5978	4.4808
180	1002.34	0.001128	0.193922	0.192794	762.764	2776.39	2013.62	761.634	2582.01	1820.38	2.1363	6.5818	4.4456
182	1049.27	0.001130	0.185635	0.184504	771.613	2778.07	2006.46	770.427	2583.29	1812.87	2.1555	6.5660	4.4105
184	1097.91	0.001133	0.177767	0.176634	780.480	2779.71	1999.23	779.236	2584.54	1805.30	2.1747	6.5502	4.3756
186	1148.30	0.001136	0.170295	0.169159	789.364	2781.29	1991.93	788.060	2585.74	1797.68	2.1938	6.5346	4.3408
188	1200.50	0.001139	0.163195	0.162057	798.266	2782.82	1984.56	796.899	2586.91	1790.01	2.2129	6.5191	4.3062
190	1254.53	0.001141	0.156446	0.155304	807.187	2784.30	1977.11	805.755	2588.03	1782.28	2.2319	6.5037	4.2718
192	1310.45	0.001144	0.150027	0.148882	816.127	2785.72	1969.60	814.627	2589.12	1774.49	2.2508	6.4883	4.2375
194	1368.30	0.001147	0.143919	0.142772	825.086	2787.09	1962.01	823.516	2590.17	1766.65	2.2697	6.4731	4.2033
196	1428.14	0.001150	0.138105	0.136955	834.064	2788.41	1954.34	832.422	2591.18	1758.75	2.2886	6.4579	4.1693
198	1489.99	0.001153	0.132568	0.131415	843.063	2789.67	1946.61	841.345	2592.14	1750.80	2.3074	6.4428	4.1354
200	1553.92	0.001156	0.127293	0.126137	852.082	2790.87	1938.79	850.286	2593.07	1742.78	2.3262	6.4279	4.1017

(3) (a) Consider an ideal cycle of piston-cylinder spark-ignition engine (Otto cycle), the **P-*v*** (pressure-volume) **diagram** is shown below. Draw the corresponding **T-s** (temperature-entropy) **diagram**. (label stage 1-2-3-4 in your answer) (10%)



(b) For an actual four stroke piston-cylinder spark-ignition engine (shown below), what would be the corresponding **P-v diagram** looks like? (10 %)

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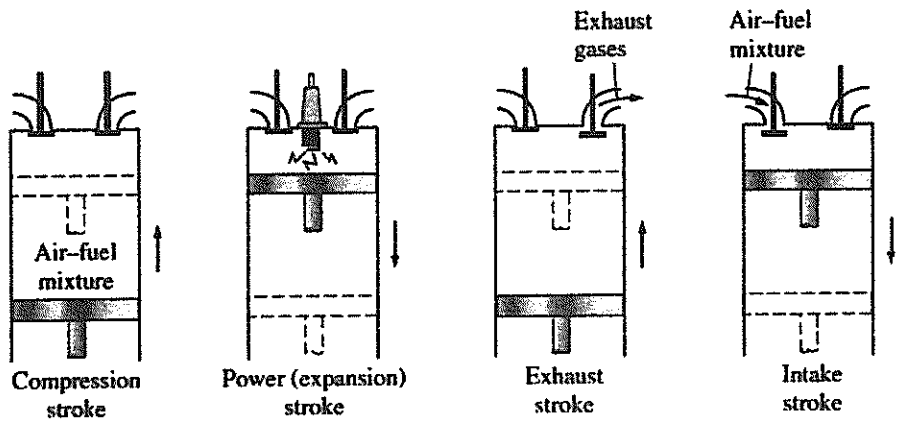

(c) In thermodynamic power-cycles, what are the major three causes/or mechanism that deviate the system from the ideal system? (You may list the basic requirements of the ideal power-cycle; 5%)

(4) (a) In thermodynamic system, some properties (i.e., entropy) cannot be measured directly, thus one adapts the Maxwell relationship that correlates them to the changes of pressure (P), temperature (T) and volume (v). What is (are) the fundamental postulate(s) that Maxwell relationship holds? (10%)

Maxwell relationship:

$$\left(\frac{\partial T}{\partial v}\right)_s = -\left(\frac{\partial P}{\partial s}\right)_v$$
$$\left(\frac{\partial T}{\partial P}\right)_s = \left(\frac{\partial v}{\partial s}\right)_P$$
$$\left(\frac{\partial s}{\partial v}\right)_T = \left(\frac{\partial P}{\partial T}\right)_v$$
$$\left(\frac{\partial s}{\partial P}\right)_T = -\left(\frac{\partial v}{\partial T}\right)_P$$

(b) How would one use the Maxwell relationship to calculate the change of internal energy (***du***) and the change of entropy (***ds***) for an ideal compressible gas process? Given constant volume specific heat ratio ***Cv***. (15%)

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