



**ELIZADE UNIVERSITY, ILARA-MOKIN,  
ONDO STATE, NIGERIA  
DEPARTMENT OF MECHANICAL ENGINEERING**

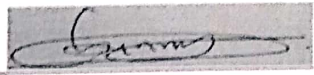
**SECOND SEMESTER EXAMINATION  
2018/2019 ACADEMIC SESSION**

**COURSE:** GNE 236 – Basic Thermodynamics (2 Units)

**CLASS:** 200 Level General Engineering

**TIME ALLOWED:** 2 Hours

**INSTRUCTION:** Answer Four (4) questions. Question No. 1 is compulsory.

  
**HOD'S SIGNATURE**

**Date:** July, 2019

**QUESTION 1 (15 marks)**

- (1a) The gas in a cubical volume with sides at different temperatures is suddenly isolated with reference to transfer of mass and energy. Is this system in thermodynamic equilibrium? Why
- (1b) A room is heated by an iron that is left plugged in. Is this a heat or work interaction? Why. Take the entire room, including the iron, as the system.
- (1c) A househusband is cooking beef stew for his family in a pan that is (a) uncovered, (b) covered with a light lid, and (c) covered with a heavy lid. For which case will the cooking time be the shortest? Why?
- (1d) A large fraction of the thermal energy generated in the engine of a car is rejected to the air by the radiator through the circulating water. Should the radiator be analyzed as a closed system or as an open system? Explain.
- (1e) Identify which of the following are extensive properties and which are intensive properties: (a) a 10-m<sup>3</sup> volume, (b) 30 J of kinetic energy, (c) a pressure of 90 kPa, (d) a stress of 1000 kPa, (e) a mass of 75 kg, and (f) a velocity of 60 m/s.

**QUESTION 2 (15 marks)**

- (2a) Define the following:  
 (i) Isobaric process (ii) Isothermal process (iii) Isochoric (iv) Isentropic (v) Isenthalpic (vi) Enthalpy
- (2b) What is the difference between the macroscopic and microscopic forms of energy?
- (2c) Complete the following if  $g = 9.81 \text{ m/s}^2$  and volume ( $V$ ) = 10 m<sup>3</sup>

	Spec. Volume $\nu$ (m <sup>3</sup> /kg)	Density $\rho$ (Kg/m <sup>3</sup> )	Spec. Weight $\gamma$ (N/m <sup>3</sup> )	Mass M (kg)	Weight W (N)
a			4		
b				100	
c					100

### QUESTION 3

- (3a) Explain the following: (a) Pure substance (b) Triple point (c) Critical point (d) Compressed liquid (e) Saturated liquid (f) saturated vapor (g) Saturation temperature (h) Saturation pressure
- (3b) In what forms can energy cross the boundaries of a closed system? Explain these forms of energy.
- (3c) A system undergoes a cycle consisting of the three processes listed in the table. Compute the missing values. All quantities are in KJ.

Process	Q	W	$\Delta E$
1 $\rightarrow$ 2	a	100	100
2 $\rightarrow$ 3	b	-150	c
3 $\rightarrow$ 1	100	d	-200

### Question 4

- (4a) Explain the Zeroth and First law of thermodynamics.
- (4b) Mention the limitations of the first law.
- (4c) A system receives  $10 \times 10^6$  J in the form of heat energy in a specified process and it produces work of  $4 \times 10^6$  J. The system velocity changes from 10 m/s to 25 m/s. For 50kg mass of the system, determine the change in internal energy of the system per kilogram.

### Question 5

- (5a) State the two statements of Second law of thermodynamics
- (5b) Explain the following: i) Heat source ii) Heat sink iii) Heat pump iv) Reverse heat engine (v) Heat engine (vi) Reversible process (vii) Irreversible process
- (5c) Find the temperature which has the same value on both the Celsius and Fahrenheit scales.

### Question 6

- (6a) Explain the Molecular phenomenon involved in each phase of pure substance.
- (6b) Explain the three properties diagrams use to study the variation of properties during phase-change processes.
- (6c) A rigid tank contains 10 kg of water at 90°C. If 8 kg of the water is in the liquid form and the rest is in the vapor form, determine (a) the pressure in the tank and (b) the volume of the tank.

T C	$P_{sat}$ kPa	$v_f$ m <sup>3</sup> /kg	$v_g$ m <sup>3</sup> /kg	$v_{fg}$ m <sup>3</sup> /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
0	0.6119	0.000995	205.94	205.93	0.9007	2500.02	2499.12	0.9001	2374.02	2373.12	-0.0013	9.1582	9.1595
2	0.7066	0.000995	179.63	179.63	9.2488	2504.40	2495.15	9.2481	2377.48	2368.24	0.0297	9.1052	9.0755
4	0.8140	0.000996	157.04	157.04	17.5909	2508.60	2491.01	17.5901	2380.76	2363.17	0.0604	9.0531	8.9928
6	0.9357	0.000996	137.59	137.59	25.9279	2512.64	2486.72	25.9269	2383.90	2357.97	0.0908	9.0020	8.9113
8	1.0732	0.000997	120.82	120.82	34.2606	2516.58	2482.31	34.2595	2386.91	2352.66	0.1209	8.9519	8.8309
10	1.2282	0.000997	106.31	106.31	42.5897	2520.42	2477.83	42.5885	2389.84	2347.25	0.1508	8.9026	8.7518
12	1.4026	0.000998	93.74	93.74	50.9160	2524.19	2473.27	50.9146	2392.70	2341.79	0.1804	8.8542	8.6738
14	1.5985	0.000999	82.83	82.83	59.2401	2527.90	2468.66	59.2385	2395.51	2336.27	0.2098	8.8066	8.5969
16	1.8180	0.000999	73.33	73.33	67.5625	2531.58	2464.02	67.5607	2398.27	2330.71	0.2389	8.7599	8.5211
18	2.0635	0.001000	65.04	65.04	75.8837	2535.23	2459.34	75.8817	2401.01	2325.13	0.2678	8.7141	8.4463
20	2.3376	0.001000	57.80	57.80	84.2043	2538.85	2454.65	84.2020	2403.73	2319.53	0.2964	8.6690	8.3725
22	2.6431	0.001001	51.47	51.46	92.5247	2542.46	2449.94	92.5220	2406.43	2313.91	0.3249	8.6247	8.2998
24	2.9830	0.001002	45.90	45.90	100.845	2546.06	2445.21	100.842	2409.12	2308.28	0.3531	8.5811	8.2280
26	3.3604	0.001002	41.02	41.02	109.166	2549.65	2440.48	109.163	2411.81	2302.65	0.3811	8.5384	8.1572
28	3.7789	0.001003	36.72	36.71	117.488	2553.23	2435.74	117.484	2414.49	2297.01	0.4090	8.4963	8.0874
30	4.2420	0.001004	32.92	32.92	125.811	2556.81	2431.00	125.807	2417.17	2291.36	0.4366	8.4550	8.0184
32	4.7536	0.001005	29.57	29.56	134.136	2560.39	2426.25	134.131	2419.84	2285.71	0.4640	8.4143	7.9503
34	5.3181	0.001005	26.60	26.60	142.462	2563.96	2421.50	142.456	2422.52	2280.06	0.4913	8.3744	7.8831
36	5.9398	0.001006	23.96	23.96	150.790	2567.53	2416.74	150.784	2425.19	2274.40	0.5183	8.3351	7.8168
38	6.6235	0.001007	21.62	21.62	159.120	2571.09	2411.97	159.113	2427.86	2268.74	0.5452	8.2964	7.7512
40	7.3743	0.001008	19.54	19.54	167.452	2574.65	2407.20	167.444	2430.52	2263.08	0.5719	8.2584	7.6865
42	8.1975	0.001009	17.69	17.69	175.786	2578.20	2402.41	175.778	2433.18	2257.41	0.5985	8.2210	7.6226
44	9.0987	0.001009	16.04	16.03	184.123	2581.75	2397.63	184.114	2435.84	2251.73	0.6248	8.1843	7.5594
46	10.084	0.001010	14.56	14.56	192.463	2585.29	2392.83	192.452	2438.50	2246.04	0.6510	8.1481	7.4970
48	11.160	0.001011	13.23	13.23	200.805	2588.82	2388.02	200.794	2441.14	2240.35	0.6771	8.1125	7.4354
50	12.333	0.001012	12.05	12.04	209.150	2592.34	2383.19	209.137	2443.78	2234.65	0.7030	8.0775	7.3745
52	13.610	0.001013	10.98	10.98	217.498	2595.86	2378.36	217.484	2446.42	2228.93	0.7287	8.0430	7.3143

T C	P <sub>sat</sub> kPa	v <sub>f</sub> m <sup>3</sup> /kg	v <sub>g</sub> m <sup>3</sup> /kg	v <sub>fg</sub> m <sup>3</sup> /kg	h <sub>f</sub> kJ/kg	h <sub>g</sub> kJ/kg	h <sub>fg</sub> kJ/kg	u <sub>f</sub> kJ/kg	u <sub>g</sub> kJ/kg	u <sub>fg</sub> kJ/kg	s <sub>f</sub> kJ/kg K	s <sub>g</sub> kJ/kg K	s <sub>fg</sub> kJ/kg K
54	14.999	0.001014	10.02	10.02	225.848	2599.36	2373.51	225.833	2449.04	2223.21	0.7543	8.0091	7.2547
56	16.507	0.001015	9.159	9.158	234.202	2602.85	2368.65	234.185	2451.66	2217.48	0.7798	7.9757	7.1959
58	18.143	0.001016	8.381	8.380	242.558	2606.34	2363.78	242.540	2454.27	2211.73	0.8051	7.9428	7.1377
60	19.916	0.001017	7.679	7.678	250.918	2609.80	2358.89	250.898	2456.87	2205.97	0.8302	7.9104	7.0802
62	21.834	0.001018	7.044	7.043	259.281	2613.26	2353.98	259.259	2459.46	2200.20	0.8552	7.8786	7.0234
64	23.906	0.001019	6.470	6.469	267.647	2616.70	2349.05	267.623	2462.04	2194.41	0.8801	7.8472	6.9671
66	26.144	0.001020	5.949	5.948	276.016	2620.13	2344.11	275.990	2464.61	2188.62	0.9048	7.8163	6.9115
68	28.557	0.001021	5.476	5.475	284.389	2623.54	2339.15	284.360	2467.16	2182.80	0.9294	7.7859	6.8564
70	31.156	0.001023	5.047	5.046	292.765	2626.94	2334.18	292.733	2469.71	2176.97	0.9539	7.7559	6.8020
72	33.952	0.001024	4.656	4.655	301.144	2630.32	2329.18	301.109	2472.24	2171.13	0.9782	7.7263	6.7481
74	36.957	0.001025	4.300	4.299	309.527	2633.69	2324.16	309.489	2474.76	2165.27	1.0024	7.6972	6.6948
76	40.184	0.001026	3.976	3.975	317.913	2637.04	2319.13	317.872	2477.27	2159.40	1.0265	7.6686	6.6421
78	43.645	0.001028	3.680	3.679	326.303	2640.37	2314.07	326.258	2479.76	2153.51	1.0505	7.6403	6.5899
80	47.353	0.001029	3.409	3.408	334.696	2643.69	2308.99	334.648	2482.25	2147.60	1.0743	7.6125	6.5382
82	51.322	0.001030	3.162	3.161	343.093	2646.99	2303.90	343.040	2484.72	2141.68	1.0980	7.5850	6.4870
84	55.567	0.001032	2.935	2.934	351.494	2650.27	2298.78	351.437	2487.17	2135.74	1.1216	7.5579	6.4364
86	60.102	0.001033	2.727	2.726	359.899	2653.53	2293.64	359.837	2489.62	2129.78	1.1450	7.5313	6.3862
88	64.942	0.001034	2.537	2.536	368.308	2656.78	2288.47	368.240	2492.04	2123.80	1.1684	7.5050	6.3366
90	70.104	0.001036	2.361	2.360	376.720	2660.01	2283.29	376.648	2494.46	2117.81	1.1916	7.4790	6.2874
92	75.603	0.001037	2.200	2.199	385.137	2663.21	2278.08	385.059	2496.86	2111.80	1.2147	7.4534	6.2387
94	81.457	0.001039	2.052	2.051	393.558	2666.40	2272.84	393.474	2499.25	2105.77	1.2377	7.4282	6.1905
96	87.683	0.001040	1.915	1.914	401.984	2669.57	2267.58	401.893	2501.62	2099.73	1.2606	7.4033	6.1427
98	94.299	0.001042	1.789	1.788	410.414	2672.72	2262.30	410.316	2503.98	2093.66	1.2833	7.3787	6.0954
100	101.325	0.001043	1.673	1.672	418.849	2675.84	2256.99	418.743	2506.32	2087.57	1.3060	7.3545	6.0485
102	108.778	0.001045	1.566	1.565	427.289	2678.95	2251.66	427.175	2508.64	2081.47	1.3285	7.3306	6.0020
104	116.678	0.001046	1.466	1.465	435.733	2682.03	2246.30	435.611	2510.95	2075.34	1.3510	7.3070	5.9560
106	125.047	0.001048	1.374	1.373	444.183	2685.09	2240.91	444.052	2513.25	2069.19	1.3733	7.2837	5.9103
108	133.905	0.001050	1.289	1.288	452.638	2688.13	2235.49	452.498	2515.52	2063.03	1.3955	7.2606	5.8651
110	143.273	0.001051	1.210	1.209	461.099	2691.14	2230.04	460.948	2517.78	2056.83	1.4177	7.2379	5.8203