

# APPENDIX

Table 1 Ideal-gas specific heats of various common gases at 300 K

Gas	Formula	Gas constant $R$ $\text{kJ}/(\text{kg}\cdot\text{K})$	$c_p$ $\text{kJ}/(\text{kg}\cdot\text{K})$	$c_v$ $\text{kJ}/(\text{kg}\cdot\text{K})$	$\gamma$
Air	—	0.2870	1.005	0.718	1.400
Argon	Ar	0.2081	0.5203	0.3122	1.667
Butane	$\text{C}_4\text{H}_{10}$	0.1433	1.7164	1.5734	1.091
Carbon dioxide	$\text{CO}_2$	0.1889	0.846	0.657	1.289
Carbon monoxide	CO	0.2968	1.040	0.744	1.400
Ethane	$\text{C}_2\text{H}_6$	0.2765	1.7662	1.4897	1.186
Ethylene	$\text{C}_2\text{H}_4$	0.2964	1.5482	1.2518	1.237
Helium	He	2.0769	5.1926	3.1156	1.667
Hydrogen	$\text{H}_2$	4.1240	14.307	10.183	1.405
Methane	$\text{CH}_4$	0.5182	2.2537	1.7354	1.299
Neon	Ne	0.4119	1.0299	0.6179	1.667
Nitrogen	$\text{N}_2$	0.2968	1.039	0.743	1.400
Octane	$\text{C}_8\text{H}_{18}$	0.0729	1.7113	1.6385	1.044
Oxygen	$\text{O}_2$	0.2598	0.918	0.658	1.395
Propane	$\text{C}_3\text{H}_8$	0.1885	1.6794	1.4909	1.126
Steam	$\text{H}_2\text{O}$	0.4615	1.8723	1.4108	1.327

Table 2 Saturated Steam (temperature) table

Temp °C $T$	Sat. press. kPa $P_{\text{sat}}$	Specific volume $\text{m}^3/\text{kg}$		Internal energy $\text{kJ}/\text{kg}$			Enthalpy $\text{kJ}/\text{kg}$			Entropy $\text{kJ}/(\text{kg}\cdot\text{K})$		
		Sat. liquid $v_f$	Sat. vapour $v_g$	Sat. liquid $u_f$	Sat.		Sat. liquid $h_f$	Sat.		Sat. liquid $s_f$	Sat.	
					Evap. $u_{fg}$	vapour $u_g$		Evap. $h_{fg}$	vapour $h_g$		Evap. $s_{fg}$	vapour $s_g$
0.01	0.6113	0.001000	206.14	0.0	2375.3	2375.3	0.01	2501.4	2501.4	0.000	9.1562	9.1562
5	0.8721	0.001000	147.12	20.97	2361.3	2382.3	20.98	2489.6	2510.6	0.0761	8.9496	9.0257
10	1.2276	0.001000	106.38	42.00	2347.2	2389.2	42.01	2477.7	2519.8	0.1510	8.7498	8.9008
15	1.7051	0.001001	77.93	62.99	2333.1	2396.1	62.99	2465.9	2528.9	0.2245	8.5569	8.7814
20	2.339	0.001002	57.79	83.95	2319.0	2402.9	83.96	2454.1	2538.1	0.2966	8.3706	8.6672
25	3.169	0.001003	43.36	104.88	2409.8	2309.8	104.89	2442.3	2547.2	0.3674	8.1905	8.5580
30	4.246	0.001004	32.89	125.78	2290.8	2416.6	125.79	2430.5	2556.3	0.4369	8.0164	8.4533
35	5.628	0.001006	25.22	146.67	2276.7	2423.4	146.68	2418.6	2565.3	0.5053	7.8478	8.3531
40	7.384	0.001008	19.52	167.56	2262.6	2430.1	167.57	2406.7	2574.3	0.5725	7.6845	8.2570
45	9.593	0.001010	15.26	188.44	2248.4	2436.8	188.45	2394.8	2583.2	0.6387	7.5261	8.1648
50	12.349	0.001012	12.03	209.32	2234.2	2443.5	209.33	2382.7	2592.1	0.7038	7.3725	8.0763
55	15.758	0.001015	9.568	230.21	2219.9	2450.1	230.23	2370.7	2600.9	0.7679	7.2234	7.9913
60	19.940	0.001017	7.671	251.11	2205.5	2456.6	251.13	2358.5	2609.6	0.8312	7.0784	7.9096
65	25.03	0.001020	6.197	272.02	2191.1	2463.1	272.06	2346.2	2618.3	0.8935	6.9375	7.8310
70	31.19	0.001023	5.042	292.95	2176.6	2469.6	292.98	2333.8	2626.8	0.9549	6.8004	7.7553
75	38.58	0.001026	4.131	313.90	2162.0	2475.9	313.93	2321.4	2635.3	1.0155	6.6669	7.6824
80	47.39	0.001029	3.407	334.86	2147.4	2482.2	334.91	2308.8	2643.7	1.0753	6.5369	7.6122
85	57.83	0.001033	2.828	355.84	2132.6	2488.4	355.90	2296.0	2651.9	1.1343	6.4102	7.5445
90	70.14	0.001036	2.361	376.85	2117.7	2494.5	376.92	2283.2	2660.1	1.1925	6.2866	7.4791
95	84.55	0.001040	1.982	397.88	2102.7	2500.6	397.96	2270.2	2668.1	1.2500	6.1659	7.4159

Table 4 Superheated steam table

T °C	v	u	h	s	v	u	h	s	v	u	h	s
	m <sup>3</sup> /kg	kJ/kg	kJ/kg	kJ/(kg·K)	m <sup>3</sup> /kg	kJ/kg	kJ/kg	kJ/(kg·K)	m <sup>3</sup> /kg	kJ/kg	kJ/kg	kJ/(kg·K)
	P = 2.50 MPa (223.99 °C)				P = 3.00 MPa (233.90 °C)				P = 3.50 MPa (242.60 °C)			
Sat.	0.07998	2603.1	2803.1	6.2575	0.06668	2604.1	2804.2	6.1869	0.05707	2603.7	2803.4	6.1253
225	0.08027	2605.6	2806.3	6.2639					0.05872	2623.7	2829.2	6.1749
250	0.08700	2662.6	2880.1	6.4085	0.07058	2644.0	2855.8	6.2872	0.06842	2738.0	2977.5	6.4461
300	0.09890	2761.6	3008.8	6.6438	0.08114	2750.1	2993.5	6.5390	0.07678	2835.3	3104.0	6.6579
350	0.10976	2851.9	3126.3	6.8403	0.09053	2843.7	3115.3	6.7428	0.08453	2926.4	3222.3	6.8405
400	0.12010	2939.1	3239.3	7.0148	0.09936	2932.8	3230.9	6.9212	0.09196	3015.3	3337.2	7.0052
450	0.13014	3025.5	3350.8	7.1746	0.10787	3020.4	3344.0	7.0834	0.09918	3103.0	3450.9	7.1572
500	0.13993	3112.1	3462.1	7.3234	0.11619	3108.0	3456.5	7.2338	0.11324	3282.1	3678.4	7.4339
600	0.15930	3288.0	3686.3	7.5960	0.13243	3285.0	3682.3	7.5085	0.12699	3464.3	3908.8	7.6837
700	0.17832	3468.7	3914.5	7.8435	0.14838	3466.5	3911.7	7.7571	0.14056	3651.8	4143.7	7.9134
800	0.19716	3655.3	4148.2	8.0720	0.16414	3653.5	4145.9	7.9862	0.15402	3845.0	4384.1	8.1276
900	0.21590	3847.9	4387.6	8.2853	0.17980	3846.5	4385.9	8.1999	0.16743	4044.1	4630.1	8.3288
1000	0.2346	4046.7	4633.1	8.4861	0.19541	4045.4	4631.6	8.4009	0.18080	4249.2	4881.9	8.5192
1100	0.2532	4251.5	4884.6	8.6762	0.21098	4250.3	4883.3	8.5912	0.19415	4459.8	5139.3	8.7000
1200	0.2718	4462.1	5141.7	8.8569	0.22652	4460.9	5140.5	8.7720	0.20749	4675.5	5401.7	8.8723
1300	0.2905	4677.8	5404.0	9.0291	0.24206	4676.6	5402.8	8.9442				

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T °C	v	u	h	s	v	u	h	s	v	u	h	s
	m <sup>3</sup> /kg	kJ/kg	kJ/kg	kJ/(kg·K)	m <sup>3</sup> /kg	kJ/kg	kJ/kg	kJ/(kg·K)	m <sup>3</sup> /kg	kJ/kg	kJ/kg	kJ/(kg·K)
	P = 4.0 MPa (250.40 °C)				P = 4.5 MPa (257.49 °C)				P = 5.0 MPa (263.99 °C)			
Sat.	0.04978	2602.3	2801.4	6.0701	0.04406	2600.1	2798.3	6.0198	0.03944	2597.1	2794.3	5.9734
275	0.05457	2667.9	2886.2	6.2285	0.04730	2650.3	2863.2	6.1401	0.04141	2631.3	2838.3	6.0544
300	0.05884	2725.3	2960.7	6.3615	0.05135	2712.0	2943.1	6.2828	0.04532	2698.0	2924.5	6.2084
350	0.06645	2826.7	3092.5	6.5821	0.05840	2817.8	3080.6	6.5131	0.05194	2808.7	3068.4	6.4493
400	0.07341	2919.9	3213.6	6.7690	0.06475	2913.3	3204.7	6.7047	0.05781	2906.6	3195.7	6.6459
450	0.08002	3010.2	3330.3	6.9363	0.07074	3005.0	3323.3	6.8746	0.06330	2999.7	3316.2	6.8186
500	0.08643	3099.5	3445.3	7.0901	0.07651	3095.3	3439.6	7.0301	0.06857	3091.0	3433.8	6.9759
600	0.09885	3279.1	3674.4	7.3688	0.08765	3276.0	3670.5	7.3110	0.07869	3273.0	3666.5	7.2589
700	0.11095	3462.1	3905.9	7.6198	0.09847	3459.9	3903.0	7.5631	0.08849	3457.6	3900.1	7.5122
800	0.12287	3650.0	4141.5	7.8502	0.10911	3648.3	4139.3	7.7942	0.09811	3646.6	4137.1	7.7440
900	0.13469	3843.6	4382.3	8.0647	0.11965	3842.2	4380.6	8.0091	0.10762	3840.7	4378.8	7.9393
1000	0.14645	4042.9	4628.7	8.2662	0.13013	4041.6	4627.2	8.2108	0.11707	4040.4	4625.7	8.1612
1100	0.15817	4248.0	4880.6	8.4567	0.14056	4246.8	4879.3	8.4015	0.12648	4245.6	4878.0	8.3520
1200	0.16987	4458.6	5138.1	8.6376	0.15098	4457.5	5136.9	8.5825	0.13587	4456.3	5135.7	8.5331
1300	0.18156	4674.3	5400.5	8.8100	0.16139	4673.1	5399.4	8.7549	0.14526	4672.0	5398.2	8.7055