UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: MECHANICAL TECHNOLOGY*
SUBJECT	:	**THERMODYNAMICS 3**
CODE	:	**IMT313**
DATE	:	MID YEAR MAIN EXAMINATION 13 JUNE 2014
DURATION	:	08:30 - 11:30
WEIGHT	:	40:60
FULL MARKS	:	100
TOTAL MARKS	:	105

ASSESSOR	:	MR F MARTINEZ	
MODERATOR	:	MR E BAKAYA-KYAHURWA	2203
NUMBER OF PAGES	:	5 QUESTIONS ON 3 PAGES AND 2 ANNEXURES (8 PAGES TOTAL)	

INSTRUCTIONS:

- ONE CALCULATOR OF ANY MAKE OR MODEL IS PERMITTED.

REQUIREMENTS:

- NONE

2/ ....

INSTRUCTIONS TO STUDENTS:

- ANSWER ALL QUESTIONS.
- MAKE REASONABLE ASSUMPTIONS FOR DATA NOT SUPPLIED.
- NUMBER QUESTIONS CLEARLY UNDERLINING FINAL ANSWERS.
- ANSWERS WITHOUT UNITS WILL NOT BE MARKED.

QUESTION 1

The pressure and temperature at the start of an Otto Cycle are 101,3 kPa and 27 °C respectively. The compression ratio during the cycle is 5,7. The heat added during the cycle is 8,7 kJ. The mass of air processed during the cycle is 0.051kg. The air constants that can be assumed are R =287 J/kgK; γ =1,4; C_p = 1005 J/kgK and C_v = 718 J/kgK.

1.1 Draw a neatly labeled and proportioned PV and TS diagram for the cycle. (4)

Calculate the:

1.2 Pressure, volume and temperature values at each state point on the cycle. (Tabulate your answers with units) (11)

1.3 Positive work output from the cycle. (2)

1.4 Negative work input to the cycle. (2)

1.5 Net work done during the cycle. (1)

1.6 Heat rejected during the cycle. (1)

1.7 Thermal efficiency of the cycle. (2)

1.8 Work ratio of the cycle. (2)

[25]

QUESTION 2

A two stage single acting reciprocating compressor takes in air at 92 kPa and 21 °C and compresses it to a delivery pressure of 530 kPa. The index of compression and expansion for both stages is 1,2. The clearance volume of the low pressure stage is 3,8% of its swept volume. The volume of air delivered at free air conditions is 8,6 m^3 per minute. Free air conditions can be taken to be 101,3 kPa and 15 °C. The compressor is operating at minimum work conditions, ideal intermediate pressure and perfect intercooling.

2.1 Draw a neat, fully labeled and proportioned PV diagram for the cycle. (5)

2.2 Calculate the ideal intermediate pressure. (2)

2.3 Calculate the clearance volume, swept volume and the effective swept volume for the low pressure stage in m3 per second. (8)

2.4 Calculate the power required to drive the compressor. (2)

2.5 Calculate low pressure stage volumetric efficiency and clearance ratio. (4)

2.6 Calculate the low pressure stage isothermal efficiency. (4)

[25]

QUESTION 3

A commercial refrigerator making use of Refrigerant 22 operates between a maximum and minimum pressure of 7,8915 bar and 2,0098 bar respectively. The refrigerator consists of a compressor, condenser, throttle valve and evaporator. The refrigerant is compressed isentropically in the compressor to 20K above saturation temperature. At exit from the condenser, the refrigerant is a saturated liquid with no undercooling.
Properties of Refrigerant 22 are listed below:

							10K		20K	
t	P_s	v_g	h_f	h_g	S_f	S_g	h	S	h	S
(°C)	(bar)	(m^3/kg)	(kJ/kg)		(kJ/kgK)		(kJ/kg)	(kJ/kgK)	(kJ/kg)	(kJ/kgK)
-25	2,0098	0,1119	171,61	395,33	0,8919	1,7934	401,74	1,8187	408,21	1,6433
15	7,8915	0,02999	217,94	410,43	1,0631	1,7311	418,26	1,7578	425,99	1,7833

3.1 Draw a neat, fully labeled and proportioned TS and Ph diagram of the cycle. (10)

Calculate the:

3.2 Specific work done by the compressor. (9)

3.3 Specific heat transferred in the condenser. (2)

3.4 Dryness of the refrigerant at entry to the evaporator. (2)

3.5 Specific heat transferred in the evaporator. (1)

3.6 Refrigerator's coefficient of performance. (1)

[25]

QUESTION 4

During a Morse test performed on a three cylinder two stroke petrol engine 5,72 kg of fuel is consumed in a 20 minute period while the engine is running at 720 revolutions per minute. The indicated mean effective pressure is 460kPa and the swept volume per cylinder is 0,8 litres. The brake loads when each cylinder is disconnected in turn are:
F_1 = 230 N, F_2 = 228 N, F_3 = 252 N. The brake loads are applied on a brake arm 410mm long. Calculate the:

4.1 Brake power per cylinder. (3)

4.2 Engine's indicated power. (2)

4.3 Engine's mechanical efficiency. (6)

4.4 Indicated power per cylinder. (3)

4.5 Engine's brake power. (1)

4.6 Engine's brake force at full brake power. (1)

4.7 Indicated and brake specific fuel consumption in kg/kWh. (4)

[20]

QUESTION 5

Wet steam at a pressure of 860 kPa
and a dryness of 0,66 has its specific enthalpy increased at constant pressure by 260 kJ/kg.
The steam pressure is then increased adiabatically to a pressure of 1750 kPa.
For wet steam n = 1,13 and for superheated steam n = 1,3.

5.1 Calculate the change of specific enthalpy from start to end of the two processes described above.

[15]

TOTAL : 105

ANNEXURE 1: FORMULA SHEET

$$\eta_{vol} = \frac{V_{s,eff}}{V_s} = 1 - \frac{V_c}{V_s}\left[\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right]$$

$$\frac{P_f\ V_f}{T_f} = \frac{P_1\ V_1}{T_1} = \frac{P_2\ V_2}{T_2}$$

$$\oint W = \frac{n}{n-1} P_1\ V_{s,eff}\left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

$$\oint W = \frac{xn}{n-1} P_1\ V_{s,eff}\left[\left(\frac{P_{x+1}}{P_1}\right)^{\frac{n-1}{xn}} - 1\right]$$

$$K = \sqrt[x]{\frac{P_{x+1}}{P_1}}$$

$$COP = \frac{\text{refrigerating effect}}{\text{energy input}} = \frac{T_r}{T_h - T_r}$$

$$h_w = h_f + x\,(h_g - h_f)$$

$$s_w = s_f + x\,(s_g - s_f)$$

$$h_{sup} = h_g + C_{p,v}\,[T_{sup} - T_{sat}]$$

$$s_{sup} = s_g + C_{p,v}\,\ell n\left(\frac{T_{sup}}{T_{sat}}\right)$$

$$h_{sub} = h_f - C_{p,f}\,|\Delta T|$$

$$V = x\ v_g$$

$$IMEP = \left[\frac{\text{diagram area}}{\text{diagram length}}\right] \times \text{Sp.No}$$

$$IP = IMEP \times L \times A \times N \times E$$

$$BP = 2\pi N\tau = BMEP \times L \times A \times N \times E$$

$$\tau = g\,(M - s)\left(\frac{D+d}{2}\right)$$

$$FP = IP - BP = \dot{m}\,CV$$

$$\eta_m = BP/IP$$

$$BMEP = IMEP \times \eta_m$$

$$isfc = \frac{\text{fuel}\ [kg/h]}{IP\ [kW]}$$

$$\eta = \frac{IP}{FP}$$

$$\eta_{rel} = \frac{\eta}{\eta_{theor}}$$

$$\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^{\gamma}$$

$$\frac{T_1}{T_2} = \left(\frac{V_2}{V_1}\right)^{\gamma-1}$$

$$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}$$

$$H_e = M_e \times SHC_e \times \Delta T$$

$$H_c = M_c \times SHC_c \times \Delta T$$

$$MEP = \frac{\oint W}{V_s}$$

$$\text{Isotherm WD} = PV\,\ell n\left(\frac{V_2}{V_1}\right)$$

$$\text{Polytrop WD} = \frac{P_1V_1 - P_2V_2}{n-1} = \frac{mR\,(T_1 - T_2)}{n-1}$$

$$\oint W = \text{heat received} - \text{heat rejected}$$

$$\text{Isobar} \oint W = mC_p\,[(T_3 - T_4) - (T_2 - T_1)]$$

$$\text{Isochor} \oint W = mC_v\,[(T_3 - T_2) - (T_4 - T_1)]$$

$$\text{Work Ratio} = \frac{\oint W}{+\text{ve WD}}$$

$$\eta = \frac{\oint W}{Qrec} = 1 - \frac{Qreject}{Qrec}$$

$$\eta_c = 1 - \frac{1}{r_v^{\ \gamma-1}}$$

$$\eta = \eta_c \cdot \left[\frac{\alpha\,\beta^{\gamma} - 1}{(\alpha - 1) + \alpha\gamma\,(\beta - 1)}\right]$$

$$\text{Clearance Ratio} = \frac{V_c}{V_s}$$

$$\eta_{iso} = \frac{\oint Wiso}{\oint Wact}$$

ANNEXURE 2: STEAM TABLES

Properties of Water and Saturated Steam

p	t_s	v_g	h_f	h_{fg}	h_g	s_f	s_g
kPa	°C	m³/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K
1,0	7,0	129,20	29	2 485	2 514	0,106	8,977
1,5	13,0	87,98	55	2 471	2 526	0,196	8,829
2,0	17,5	67,01	74	2 460	2 534	0,261	8,725
2,5	21,1	54,26	89	2 452	2 541	0,312	8,644
3,0	24,1	45,67	101	2 445	2 546	0,354	8,579
3,5	26,7	39,48	112	2 439	2 551	0,391	8,523
4,0	29,0	34,80	121	2 433	2 554	0,423	8,476
4,5	31,0	31,14	130	2 428	2 558	0,451	8,434
5,0	32,9	28,19	138	2 424	2 562	0,476	8,396
5,5	34,6	25,77	145	2 420	2 565	0,500	8,362
6,0	36,2	23,74	152	2 416	2 568	0,521	8,331
6,5	37,7	22,02	158	2 413	2 571	0,541	8,303
7,0	39,0	20,53	163	2 410	2 573	0,559	8,277
7,5	40,3	19,24	169	2 406	2 575	0,576	8,252
8,0	41,6	18,10	174	2 403	2 577	0,593	8,230
8,5	42,7	17,10	179	2 401	2 580	0,608	8,208
9,0	43,8	16,20	183	2 398	2 581	0,622	8,188
9,5	44,8	15,40	188	2 395	2 583	0,636	8,169
10	45,8	14,67	192	2 393	2 585	0,649	8,151
11	47,7	13,42	200	2 388	2 588	0,674	8,118
12	49,5	12,36	207	2 384	2 591	0,696	8,087
13	51,1	11,47	214	2 380	2 594	0,717	8,059
14	52,6	10,69	220	2 377	2 597	0,737	8,033
15	54,0	10,02	226	2 373	2 599	0,755	8,009
16	55,3	9,433	232	2 370	2 602	0,772	7,987
17	56,6	8,911	237	2 367	2 604	0,788	7,966
18	57,8	8,445	242	2 364	2 606	0,804	7,946
19	59,0	8,027	247	2 361	2 608	0,818	7,927
20	60,1	7,650	252	2 358	2 610	0,832	7,909
21	61,1	7,307	256	2 356	2 612	0,845	7,893
22	62,2	6,995	260	2 353	2 613	0,858	7,876
23	63,1	6,709	264	2 351	2 615	0,870	7,861
24	64,1	6,447	268	2 349	2 617	0,882	7,846
25	65,0	6,204	272	2 346	2 618	0,893	7,832
26	65,9	5,980	276	2 344	2 620	0,904	7,819
27	66,7	5,772	279	2 342	2 621	0,915	7,806
28	67,6	5,579	283	2 340	2 623	0,925	7,793
29	68,3	5,398	286	2 338	2 624	0,935	7,781
30	69,1	5,229	289	2 336	2 625	0,944	7,770

p	t_s	v_g	h_f	h_{fg}	h_g	s_f	s_g
kPa	°C	m³/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K
32	70,6	4,922	296	2 332	2 628	0,962	7,747
34	72,0	4,650	302	2 329	2 631	0,980	7,727
36	73,4	4,408	307	2 326	2 633	0,996	7,707
38	74,7	4,190	313	2 322	2 635	1,011	7,688
40	75,9	3,993	318	2 319	2 637	1,026	7,671
45	78,7	3,576	330	2 312	2 642	1,060	7,631
50	81,4	3,240	341	2 305	2 646	1,091	7,595
55	83,7	2,964	351	2 299	2 650	1,119	7,562
60	86,0	2,732	360	2 294	2 654	1,145	7,533
65	88,0	2,535	369	2 288	2 657	1,170	7,506
70	90,0	2,365	377	2 283	2 660	1,192	7,480
75	91,8	2,217	385	2 279	2 664	1,213	7,457
80	93,5	2,087	392	2 274	2 666	1,233	7,435
85	95,2	1,972	399	2 270	2 669	1,252	7,415
90	96,7	1,869	405	2 266	2 671	1,270	7,395
95	98,2	1,777	412	2 262	2 674	1,287	7,377
100	99,6	1,694	418	2 258	2 676	1,303	7,360
110	102,3	1,549	429	2 251	2 680	1,333	7,328
120	104,8	1,428	439	2 244	2 683	1,361	7,300
130	107,1	1,325	449	2 238	2 687	1,387	7,272
140	109,3	1,236	458	2 232	2 690	1,411	7,247
150	111,4	1,159	467	2 226	2 693	1,434	7,223
160	113,3	1,091	475	2 221	2 696	1,455	7,202
170	115,2	1,031	483	2 216	2 699	1,475	7,181
180	116,9	0,977 2	491	2 211	2 702	1,494	7,162
190	118,6	0,929 0	498	2 206	2 704	1,513	7,144
200	120,2	0,885 4	505	2 202	2 707	1,530	7,127
210	121,8	0,845 9	511	2 197	2 708	1,547	7,111
220	123,3	0,809 8	518	2 193	2 711	1,563	7,095
230	124,7	0,776 8	524	2 189	2 713	1,578	7,080
240	126,1	0,746 5	530	2 185	2 715	1,593	7,066
250	127,4	0,718 4	535	2 181	2 716	1,607	7,052
260	128,7	0,692 5	541	2 177	2 718	1,621	7,039
270	130,0	0,668 4	546	2 174	2 720	1,634	7,026
280	131,2	0,646 0	551	2 170	2 721	1,647	7,014
290	132,4	0,625 1	557	2 167	2 724	1,660	7,002
300	133,5	0,605 6	561	2 163	2 724	1,672	6,991
310	134,7	0,587 2	566	2 160	2 726	1,683	6,980
320	135,8	0,570 0	571	2 157	2 728	1,695	6,969
330	136,8	0,553 8	576	2 154	2 730	1,706	6,959
340	137,9	0,538 5	580	2 150	2 730	1,717	6,949
350	138,9	0,524 0	584	2 147	2 731	1,727	6,939
360	139,9	0,510 3	589	2 144	2 733	1,738	6,930
370	140,8	0,497 4	593	2 141	2 734	1,748	6,921

p	t_s	v_g	h_f	h_{fg}	h_g	s_f	s_g
kPa	°C	m³/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K
380	141,8	0,485 1	597	2 139	2 736	1,757	6,912
390	142,7	0,473 4	601	2 136	2 737	1,767	6,903
400	143,6	0,462 2	605	2 133	2 738	1,776	6,894
410	144,5	0,451 6	609	2 130	2 739	1,786	6,886
420	145,4	0,441 5	612	2 128	2 740	1,795	6,878
430	146,3	0,431 8	616	2 125	2 741	1,803	6,870
440	147,1	0,422 6	620	2 122	2 742	1,812	6,862
450	147,9	0,413 8	624	2 120	2 744	1,820	6,855
460	148,7	0,405 3	627	2 117	2 744	1,829	6,847
470	149,5	0,397 2	630	2 115	2 745	1,837	6,840
480	150,3	0,389 4	634	2 112	2 746	1,845	6,833
490	151,1	0,381 9	637	2 110	2 747	1,853	6,826
500	151,8	0,374 7	640	2 107	2 747	1,860	6,819
520	153,3	0,361 1	647	2 103	2 750	1,875	6,806
540	154,8	0,348 5	653	2 098	2 751	1,890	6,793
560	156,2	0,336 7	659	2 094	2 753	1,904	6,781
580	157,5	0,325 7	665	2 089	2 754	1,918	6,769
600	158,8	0,315 5	670	2 085	2 755	1,931	6,758
620	160,1	0,305 9	676	2 081	2 757	1,944	6,748
640	161.4	0,296 8	682	2 077	2 759	1,956	6,736
660	162,6	0,288 3	687	2 073	2 760	1,968	6.725
680	163,8	0,280 3	692	2 069	2 761	1,980	6,715
700	165,0	0,272 7	697	2 065	2 762	1,992	6,705
720	166,1	0,265 5	702	2 061	2 763	2,003	6,696
740	167,2	0,258 7	707	2 057	2 764	2,014	6,686
760	168,3	0,252 2	712	2 054	2 766	2,025	6,677
780	169,4	0,246 1	717	2 050	2 767	2,035	6,668
800	170,4	0,240 3	721	2 047	2 768	2,046	6,660
820	171,4	0,234 7	725	2 043	2 768	2,056	6,651
840	172,5	0,229 4	730	2 040	2 770	2,066	6,643
860	173,4	0,224 3	734	2 036	2 770	2,075	6,635
880	174,4	0,219 5	739	2 033	2 772	2,085	6,627
900	175,4	0,214 8	743	2 030	2 773	2,094	6,619
920	176,3	0,210 4	747	2 026	2 773	2,103	6,612
940	177,2	0,206 1	751	2 023	2 774	2,112	6,604
960	178,1	0,202 0	755	2 020	2 775	2,121	6,597
980	179,0	0,198 1	759	2 017	2 776	2,130	6,590
1 000	179,9	0,194 3	763	2 014	2 777	2,138	6,583
1 050	182,0	0,185 5	772	2 006	2 778	2,159	6,566
1 100	184,1	0,177 4	781	1 999	2 780	2,179	6,550
1 150	186,1	0,170 0	790	1 991	2 781	2,198	6,534
1 200	188.0	0,163 2	798	1 984	2 782	2,216	6,519
1 250	189,8	0,156 9	807	1 977	2 784	2,234	6,505
1 300	191,6	0,151 1	815	1 971	2 786	2,251	6,491

p	t_s	v_g	h_f	h_{fg}	h_g	s_f	s_g
kPa	°C	m³/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K
1 350	193,4	0,145 7	823	1 964	2 787	2,268	6,478
1 400	195,0	0,140 7	830	1 958	2 788	2,284	6,465
1 450	196,7	0,136 0	838	1 951	2 789	2,299	6,453
1 500	198,3	0,131 7	845	1 945	2 790	2,315	6,441
1 550	199,9	0,127 5	852	1 939	2 791	2,330	6,429
1 600	201,4	0,123 7	859	1 933	2 792	2,344	6,418
1 650	202,9	0,120 1	865	1 927	2 792	2,358	6,407
1 700	204,3	0,116 6	872	1 922	2 794	2,371	6,396
1 750	205,7	0,113 4	878	1 916	2 794	2,385	6,385
1 800	207,1	0,110 3	885	1 910	2 795	2,398	6,375
1 850	208,5	0,107 4	891	1 905	2 796	2,410	6,365
1 900	209,8	0,104 7	897	1 899	2 796	2,423	6,355
1 950	211,1	0,102 0	903	1 894	2 797	2,435	6,346
2 000	212,4	0,099 54	908	1 889	2 797	2,447	6,337
2 050	213,6	0,097 16	914	1 883	2 797	2,459	6,328
2 100	214,9	0,094 89	920	1 878	2 798	2,470	6,319
2 150	216,1	0,092 72	926	1 873	2 799	2,481	6,310
2 200	217,2	0,090 65	931	1 868	2 799	2,492	6,302
2 250	218,4	0,088 67	936	1 863	2 799	2,503	6,293
2 300	219,6	0,086 77	942	1 858	2 800	2,514	6,285
2 350	220,7	0,084 95	947	1 853	2 800	2,524	6,277
2 400	221,8	0,083 20	952	1 849	2 801	2,534	6,269
2 450	222,9	0,081 52	957	1 844	2 801	2,544	6,261
2 500	223,9	0,079 91	962	1 839	2 801	2,554	6,254
2 550	225,0	0,078 35	967	1 834	2 801	2,564	6,246
2 600	226,0	0,076 86	972	1 830	2 802	2,574	6,239
2 650	227,1	0,075 41	977	1 825	2 802	2,583	6,232
2 700	228,1	0,074 02	981	1 821	2 802	2,592	6,224
2 750	229,1	0,072 68	986	1 816	2 802	2,602	6,217
2 800	230,1	0,071 39	991	1 811	2 802	2,611	6,210
2 850	231,0	0,070 14	995	1 807	2 802	2,620	6,204
2 900	232,0	0,068 93	1 000	1 802	2 802	2,628	6,197
2 950	232,9	0,067 76	1 004	1 798	2 802	2,637	6,190
3 000	233,8	0,066 63	1 008	1 794	2 802	2,646	6,184
3 100	235,7	0,064 47	1 017	1 785	2 802	2,662	6,171
3 200	237,5	0,062 44	1 025	1 777	2 802	2,679	6,159
3 300	239,2	0,060 53	1 034	1 768	2 802	2,695	6,146
3 400	240,9	0,058 73	1 042	1 760	2 802	2,710	6,134
3 500	242,5	0,057 03	1 050	1 752	2 802	2,725	6,123
3 600	244,2	0,055 41	1 058	1 744	2 802	2,740	6,112
3 700	245,8	0,053 89	1 065	1 736	2 801	2,755	6,100
3 800	247,3	0,052 44	1 073	1 728	2 801	2,769	6,090
3 900	248,8	0,051 06	1 080	1 721	2 801	2,783	6,079
4 000	250,3	0,049 75	1 087	1 713	2 800	2,797	6,069

p	t_s	v_g	h_f	h_{fg}	h_g	s_f	s_g
kPa	°C	m³/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K
4 100	251,8	0,048 50	1 095	1 705	2 800	2,810	6,058
4 200	253,2	0,047 31	1 102	1 698	2 800	2,823	6,048
4 300	254,7	0,046 17	1 109	1 690	2 799	2,836	6,038
4 400	256,1	0,045 08	1 115	1 683	2 798	2,849	6,029
4 500	257,4	0,044 04	1 122	1 676	2 798	2,861	6,019
4 600	258,8	0,043 04	1 129	1 668	2 797	2,874	6,010
4 700	260,1	0,042 08	1 135	1 661	2 796	2,886	6,000
4 800	261,4	0,041 16	1 142	1 654	2 796	2,897	5,991
4 900	262,7	0,040 28	1 148	1 647	2 795	2,909	5,982
5 000	263,9	0,039 43	1 155	1 640	2 795	2,921	5,974
5 100	265,2	0,038 61	1 161	1 633	2 794	2,932	5,965
5 200	266,4	0,037 82	1 167	1 626	2 793	2,943	5,956
5 300	267,6	0,037 07	1 173	1 619	2 792	2,954	5,948
5 400	268,8	0,036 33	1 179	1 612	2 791	2,965	5,939
5 500	269,9	0,035 63	1 185	1 605	2 790	2,976	5,931
5 600	271,1	0,034 95	1 191	1 598	2 789	2,988	5,923
5 700	272,2	0,034 29	1 197	1 591	2 788	2,997	5,915
5 800	273,4	0.033 65	1 202	1 585	2 787	3,007	5,907
5 900	274,5	0,033 03	1 208	1 578	2 786	3,017	5,899
6 000	275,6	0,032 44	1 214	1 571	2 785	3,027	5,891
6 200	277,7	0,031 30	1 225	1 558	2 783	3,047	5,875
6 400	279,8	0,030 23	1 236	1 545	2 781	3,066	5,860
6 600	281,8	0,029 22	1 247	1 532	2 779	3,085	5,845
6 800	283,8	0,028 27	1 257	1 519	2 776	3,104	5,831
7 000	285,8	0,027 37	1 267	1 506	2 773	3,122	5,816
7 200	287,7	0,026 52	1 278	1 493	2 771	3,140	5,802
7 400	289,6	0,025 72	1 288	1 481	2 769	3,157	5,788
7 600	291,4	0,024 95	1 298	1 468	2 766	3,174	5,774
7 800	293,2	0,024 22	1 307	1 455	2 762	3,191	5,761
8 000	295,0	0,023 53	1 317	1 443	2 760	3,208	5,747
8 200	296,7	0,022 86	1 327	1 430	2 757	3,224	5,734
8 400	298,4	0,022 23	1 336	1 418	2 754	3,240	5,721
8 600	300,1	0,021 63	1 345	1 406	2 751	3,256	5,708
8 800	301,7	0,021 05	1 355	1 393	2 748	3,271	5,695
9 000	303,3	0,020 50	1 364	1 381	2 745	3,287	5,682
9 200	304,9	0,019 96	1 373	1 369	2 742	3,302	5,669
9 400	306,4	0,019 45	1 382	1 356	2 738	3,317	5,657
9 600	308,0	0,018 97	1 391	1 344	2 735	3,332	5,644
9 800	309,5	0,018 49	1 399	1 332	2 731	3,346	5,632
10 000	311,0	0,018 04	1 408	1 320	2 728	3,361	5,620
10 400	313,4	0,017 18	1 425	1 295	2 720	3,389	5,596
10 800	316,7	0,016 39	1 442	1 271	2 713	3,417	5,572
11 200	319,4	0,015 64	1 459	1 247	2 706	3,444	5,548
11 600	322,1	0,014 94	1 475	1 222	2 697	3,471	5,524

p	t_s	v_g	h_f	h_{fg}	h_g	s_f	s_g
kPa	°C	m³/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K
12 000	324,7	0,014 28	1 492	1 197	2 689	3,497	5,500
12 400	327,2	0,013 66	1 508	1 173	2 681	3,523	5,477
12 800	329,6	0,013 08	1 524	1 148	2 672	3,549	5,453
13 200	332,0	0,012 52	1 540	1 122	2 662	3,574	5,429
13 600	334,4	0,012 00	1 556	1 097	2 653	3,599	5,405
14 000	336,6	0,011 50	1 572	1 071	2 643	3,624	5,380
14 400	338,9	0,011 02	1 587	1 044	2 631	3,649	5,356
14 800	341,1	0,010 56	1 603	1 018	2 621	3,674	5,331
15 200	343,2	0,010 12	1 619	990	2 609	3,698	5,305
15 600	345,3	0,009 707	1 635	963	2 598	3,723	5,279
16 000	347,3	0,009 308	1 651	934	2 585	3,747	5,253
16 400	349,3	0,008 925	1 667	906	2 573	3,772	5,227
16 800	351,3	0,008 553	1 683	876	2 559	3,797	5,199
17 200	353,2	0,008 191	1 700	844	2 544	3,824	5,171
17 600	355,1	0,007 838	1 718	812	2 530	3,850	5,143
18 000	357,0	0,007 498	1 735	779	2 514	3,877	5,113
18 400	358,8	0,007 165	1 752	745	2 497	3,903	5,082
18 800	360,6	0,006 839	1 770	710	2 480	3,929	5,050
19 200	362,3	0,006 517	1 788	673	2 461	3,957	5,016
19 600	364,0	0,006 198	1 807	634	2 441	3,985	4,980
20 000	365,7	0,005 877	1 827	592	2 419	4,015	4,941