UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama

Sidang Akademik 1988/89

EBB 207 TERMODINAMIK KEJURUTERAAN

Tarikh: 4 November 1988 Masa: 2.45 petang - 5.45 petang
(3 jam)

ARAHAN KEPADA CALON

1. Sila pastikan bahawa kertas soalan ini mengandungi TUJUH mukasurat bercetak sebelum anda memulakan peperiksaan ini.

2. Jawab 5 soalan sahaja.

3. Pastikan kertas peperiksaan ini mengandungi ENAM (6) soalan semuanya.

4. Semua soalan MESTILAH dijawab di dalam Bahasa Malaysia.

1. a) Nyatakan Hukum Termodinamik Pertama. (15 markah)

b) 0.9 kg bendalir pada tekanan 15 bar dan suhu 250^{o} C dikembangkan mengikuti proses politropik ke tekanan 1.5 bar. Tentukan suhu akhir kerja terlaku haba terpindah dan perubahan entropi jika indeks proses 1.25 bagi:-

a) stim

b) Nitrogen N_2

Lukiskan proses tersebut ke atas gambarajah p-v.

Nilai haba tentu bagi Nitrogen

C_p = 1.039 kJ/kg K

C_v = 0.743 kJ/kg K (85 markah)

2. a) Apakah perbezaan sistem tertutup dengan sistem terbuka. (10 markah)

b) Turbin stim direkabentuk supaya kadar alir jisim adalah 1.5 kg/s. Keadaan di alur masuk ialah P_1 = 2MPa, T_1 = 400^{o} C dan C_1 = 60 m/s. Keadaan di alur keluar ialah P_2 = 0.1 MPa, pecahan kekeringan x_2 = 0.98 dan C_2 = 150 m/s. Perubahan ketinggian di antara alur masuk dengan alur keluar adalah 1.0 m. Haba hilang adalah 50 kW.

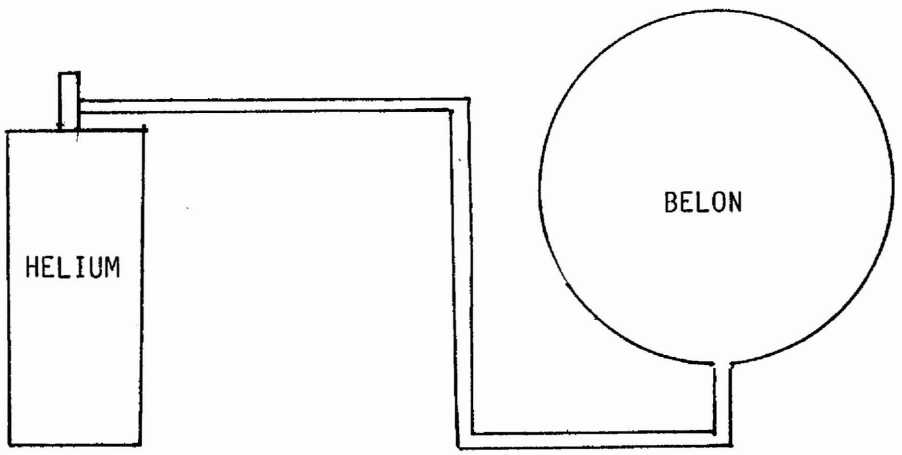
i) Tentukan kuasa keluar dari turbin
ii) Tentukan kuasa keluar jika proses berkenaan adalah adiabatik.
iii) Tentukan kuasa keluar jika diabaikan tenaga kinetik dan tenaga upaya. Bandingkan dan komenkan ketiga-tiga jawapan anda.
iv) Apakah garispusat paip di alur masuk dan di alur keluar.

(70 markah)

b) Sebuah belon diisi dengan gas helium, lihat Rajah 1. Tekanan di dalam tangki adalah tetap. Sebuah injap mengawal aliran helium supaya mengalir dengan kadar malar 0.05 kg/s. Tekanan di dalam belon berubah semasa proses mengisi. Suhu helium memasuki belon adalah 20^{o} C.

i) Tentukan kerja terlaku di dalam mengisi belon hingga ke tekanan 500 kPa apabila jejari belon 2m. Andaikan proses adiabatik dan mengambil 8 min untuk mengisi belon.

ii) Apakah suhu akhir belon. (30 markah)



Rajah 1

Data bagi helium

R = 2.077 kJ/kg K

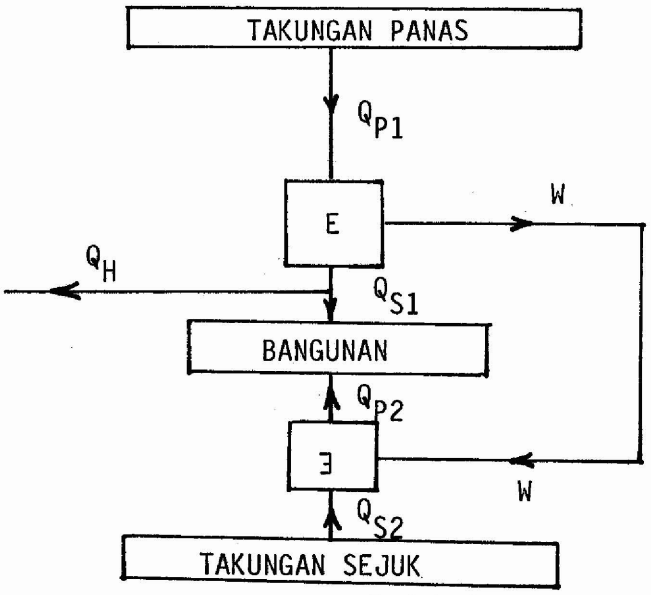
C_p = 5.1926 kJ/kg K

C_v = 3.1156 kJ/kg K

3. a) Nyatakan Hukum termodinamik kedua dan buktikan bahawa mustahil wujud engin yang mempunyai kecekapan 100%.

(30 markah)

b) Rajah 2 menunjukkan sistem pemanasan yang digunakan di negara England. Sistem tersebut menggunakan engin haba untuk menggendalikan pam haba.



Rajah 2

Data selanjutnya ialah

a) Haba terbekal ke engin haba 121.48 kJ/s.

b) Kuasa terhasil daripada engin haba 50 kW.

c) Hanya 55% haba keluar daripada engin haba digunakan untuk memanas bangunan.

d) Pekali prestasi pam haba = 3.2.

...5/-

Tentukan;

i) Kecekapan engin haba

ii) Haba masuk ke dalam bangunan

iii) Kecekapan keseluruhan sistem

iv) Haba hilang Q_H

(70 markah)

4. Kitar Rankine bagi stim dikendalikan di antara suhu 20^o C dan 100^o C. Kecekapan isentropik bagi turbin adalah 70%.

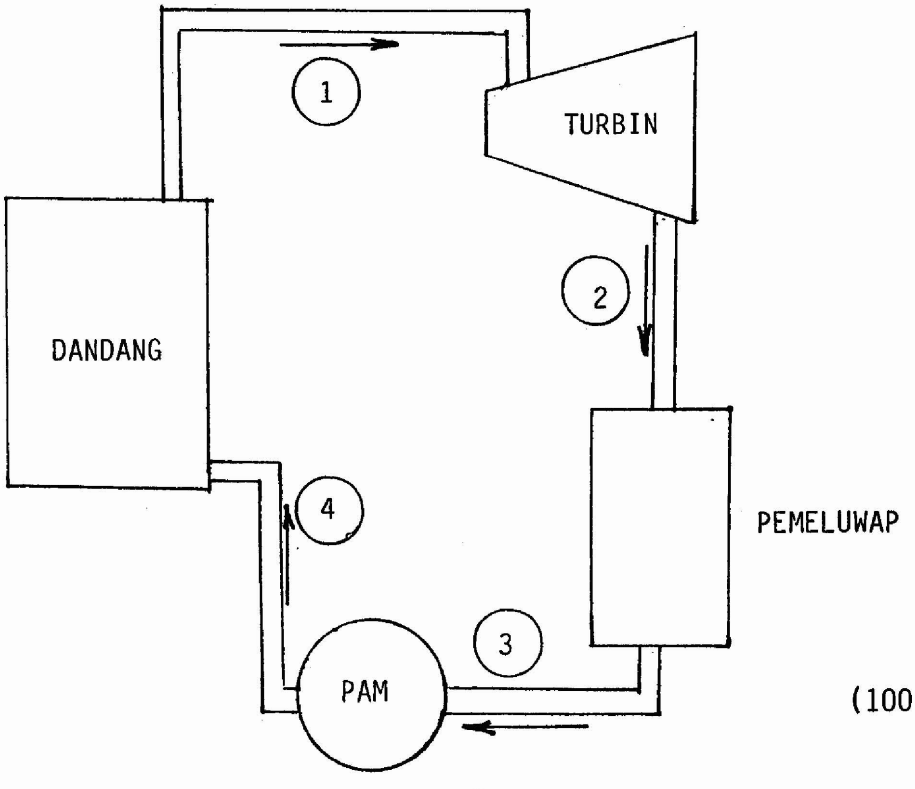
i) Lukiskan gambarajah T-S.

ii) Tentukan haba terpindah dan kerja terlaku pada setiap proses.

iii) Tentukan kecekapan kitar dan nisbah kerja.

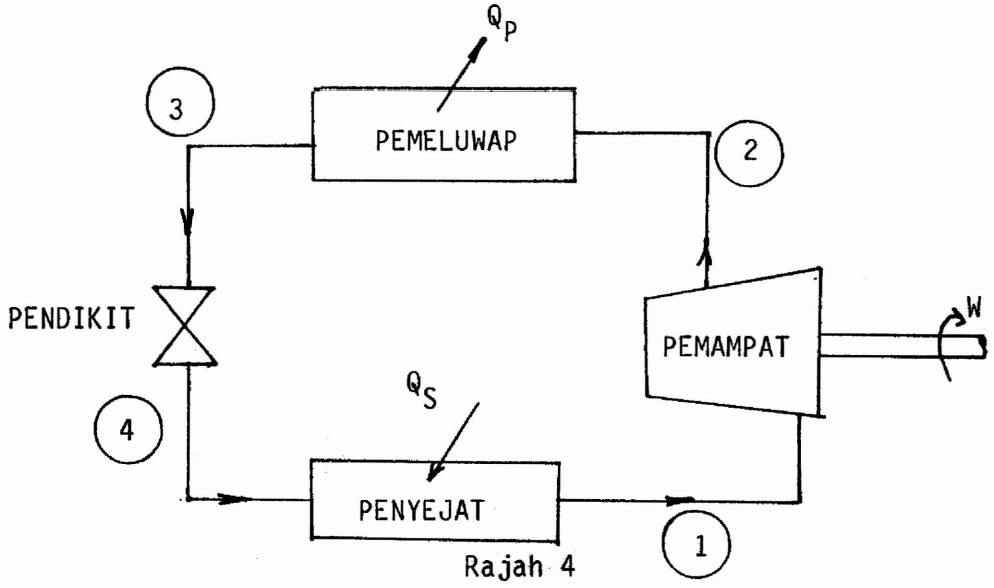
iv) Bandingkan dengan kecekapan Carnot

Rajah 3 menunjukkan kitar Rankine



(100 markah)

5. Rajah 4 menunjukkan kitar mampatan wap bagi penghawa dingin,



Rajah 4

KItar tersebut menggunakan bahan pendingin R 12. Suhu penyejat adalah - 20^{o} C dan tekanan pemeluwap adalah 9 bar. Andaikan keadaan wap memasuki pemampat adalah tepu. Kecekapan pemampat adalah 65%.

i) Lukiskan gambarajah T-ṣ.

ii) Lengkapkan jadual di bawah bagi setiap keadaan.

Keadaan	P (bar)	T(k)	h(kJ/kg)	S(kJ/kg K)	x

iii) Tentukan pekali prestasi bagi kitar tersebut dan bandingkan dengan pekali prestasi bagi kitar Carnot.

(100 markah)

...7/-

6. Kitar diesel dan kitar otto merupakan kitar piawai udara bagi engin pembakaran dalam. Keadaan udara sebelum proses mampatan adalah 1 bar dan 20^{o} C. Kedua-dua kitar mempunyai nisbah mampatan 15/1 dan haba masuk adalah 1900 kJ.

i) Lukiskan kedua-dua kitar tersebut.

ii) Tentukan suhu maksima bagi kedua-dua kitar

Data untuk udara;

C_p = 1.005 kJ/kg

C_v = 0.718 kJ/kg

iii) Tentukan kecekapan kitar bagi kedua-dua kitar tersebut. Bandingkan jawapannya dan buatkan komen anda.

iv) Tentukan tekanan berkesan min bagi kedua-dua kitar.

(100 markah)

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JADUAL

BAHAN PENDINGIN

Table A-16M Properties of saturated refrigerant 12, CCl_2F_2: temperature table
v, cm^3/g; u, kJ/kg; h, kJ/kg; s, kJ/(kg)(°K)

Temp. °C T	Press. bar(s) P	Specific volume		Internal energy		Enthalpy			Entropy	
		Sat. liquid v_f	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
−40	.6417	.6595	241.91	−0.04	154.07	0	169.59	169.59	0	.7274
−35	.8071	.6656	195.40	4.37	156.13	4.42	167.48	171.90	.0187	.7219
−30	1.0041	.6720	159.38	8.79	158.20	8.86	165.33	174.20	.0371	.7170
−25	1.2368	.6786	131.17	13.25	160.26	13.33	163.15	176.48	.0552	.7126
−20	1.5093	.6855	108.85	17.72	162.31	17.82	160.92	178.74	.0731	.7087
−15	1.8260	.6926	91.02	22.20	164.35	22.33	158.64	180.97	.0906	.7051
−10	2.1912	.7000	76.65	26.72	166.39	26.87	156.31	183.19	.1080	.7019
−5	2.6096	.7078	64.96	31.27	168.42	31.45	153.93	185.37	.1251	.6991
0	3.0861	.7159	55.39	35.83	170.44	36.05	151.48	187.53	.1420	.6965
4	3.5124	.7227	48.95	39.51	172.04	39.76	149.47	189.23	.1553	.6946
8	3.9815	.7297	43.40	43.21	173.63	43.50	147.41	190.91	.1686	.6929
12	4.4962	.7370	38.60	46.93	175.20	47.26	145.30	192.56	.1817	.6913
16	5.0591	.7446	34.42	50.67	176.78	51.05	143.14	194.19	.1948	.6898
20	5.6729	.7525	30.78	54.44	178.32	54.87	140.91	195.78	.2078	.6884
24	6.3405	.7607	27.59	58.25	179.85	58.73	138.61	197.34	.2207	.6871
28	7.0648	.7694	24.78	62.09	181.36	62.63	136.24	198.87	.2335	.6859
32	7.8485	.7785	22.31	65.96	182.85	66.57	133.79	200.36	.2463	.6847
36	8.6948	.7880	20.12	69.86	184.31	70.55	131.25	201.80	.2591	.6836
40	9.6066	.7980	18.17	73.82	185.74	74.59	128.61	203.20	.2718	.6825
44	10.587	.8086	16.44	77.82	187.13	78.68	125.87	204.54	.2845	.6814
48	11.639	.8199	14.88	81.88	188.51	82.83	123.00	205.83	.2973	.6802
52	12.766	.8318	13.49	86.00	189.83	87.06	119.99	207.05	.3101	.6791
56	13.972	.8445	12.24	90.18	191.10	91.36	116.84	208.20	.3229	.6779
60	15.259	.8581	11.11	94.43	192.31	95.74	113.52	209.26	.3358	.6765
112	41.155	1.792	1.79	175.98	175.98	183.35	0	183.35	.5687	.5687

Source: Based on data supplied by Freon Products Division, E. I. du Pont de Nemours & Company, 1969.

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Table A-17M Properties of saturated refrigerant 12, CCl_2F_2: pressure table
v, cm^3/g; u, kJ/kg; h, kJ/kg; s, kJ/(kg)(°K)

Press. bar(s) P	Temp. °C T	Specific volume		Internal energy		Enthalpy			Entropy	
		Sat. liquid v_f	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
0.6	−41.42	0.6578	257.5	−1.29	153.49	−1.25	170.19	168.94	−0.0054	0.7290
1.0	−30.10	.6719	160.0	8.71	158.15	8.78	165.37	174.15	0.0368	.7171
1.2	−25.74	.6776	134.9	12.58	159.95	12.66	163.48	176.14	.0526	.7133
1.4	−21.91	.6828	116.8	15.99	161.52	16.09	161.78	177.87	.0663	.7102
1.6	−18.49	.6876	103.1	19.07	162.91	19.18	160.23	179.41	.0784	.7076
1.8	−15.38	.6921	92.25	21.86	164.19	21.98	158.82	180.80	.0893	.7054
2.0	−12.53	.6962	83.54	24.43	165.36	24.57	157.50	182.07	.0992	.7035
2.4	−7.42	.7040	70.33	29.06	167.44	29.23	155.09	184.32	.1168	.7004
2.8	−2.93	.7111	60.76	33.15	169.26	33.35	152.92	186.27	.1321	.6980
3.2	1.11	.7177	53.51	36.85	170.88	37.08	150.92	188.00	.1457	.6960
4.0	8.15	.7299	43.21	43.35	173.69	43.64	147.33	190.97	.1691	.6928
5.0	15.60	.7438	34.82	50.30	176.61	50.67	143.35	194.02	.1935	.6899
6.0	22.00	.7566	29.13	56.35	179.09	56.80	139.77	196.57	.2142	.6878
7.0	27.65	.7686	25.01	61.75	181.23	62.29	136.45	198.74	.2324	.6860
8.0	32.74	.7802	21.88	66.68	183.13	67.30	133.33	200.63	.2487	.6845
9.0	37.37	.7914	19.42	71.22	184.81	71.93	130.36	202.29	.2634	.6832
10.0	41.64	.8023	17.44	75.46	186.32	76.26	127.50	203.76	.2770	.6820
12.0	49.31	.8237	14.41	83.22	188.95	84.21	122.03	206.24	.3015	.6799
14.0	56.09	.8448	12.22	90.28	191.11	91.46	116.76	208.22	.3232	.6778
16.0	62.19	.8660	10.54	96.80	192.95	98.19	111.62	209.81	.3329	.6758

Source: Based on data supplied by Freon Products Division, E. I. du Pont de Nemours & Company, 1969.

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Table A-18M Properties of superheated refrigerant 12 (CCl_2F_2)
v, cm^3/g; u, kJ/kg; h, kJ/kg; s, kJ/(kg)(°K)

Temp. °C	v	u	h	s	v	u	h	s
	0.6 bar (−41.42°C)				1.0 bar (−30.10°C)			
Sat.	257.5	153.49	168.94	0.7290	160.0	158.15	174.15	0.7171
−40	259.3	154.16	169.72	.7324				
−20	283.8	163.91	180.94	.7785	167.7	163.22	179.99	.7406
0	307.9	174.05	192.52	.8225	182.7	173.50	191.77	.7854
10	319.8	179.26	198.45	.8439	190.0	178.77	197.77	.8070
20	331.7	184.57	204.47	.8647	197.3	184.12	203.85	.8281
30	343.5	189.96	210.57	.8852	204.5	189.57	210.02	.8488
40	355.2	195.46	216.77	.9053	211.7	195.09	216.26	.8691
50	367.0	201.02	223.04	.9251	218.8	200.70	222.58	.8889
60	378.7	206.69	229.41	.9444	226.0	206.38	228.98	.9084
80	402.0	218.25	242.37	.9822	240.1	218.00	242.01	.9464
	1.4 bars (−21.91°C)				1.8 bars (−15.38°C)			
Sat.	116.8	161.52	177.87	0.7102	92.2	164.20	180.80	0.7054
−20	117.9	162.50	179.01	.7147				
0	128.9	172.94	190.99	.7602	99.1	172.37	190.21	.7408
10	134.3	178.28	197.08	.7821	103.4	177.77	196.38	.7630
20	139.7	183.67	203.23	.8035	107.6	183.23	202.60	.7846
30	144.9	189.17	209.46	.8243	111.8	188.77	208.89	.8057
40	150.2	194.72	215.75	.8447	116.0	194.35	215.23	.8263
50	155.3	200.38	222.12	.8648	120.1	200.02	221.64	.8464
60	160.5	206.08	228.55	.8844	124.1	205.78	228.12	.8662
80	170.7	217.74	241.64	.9225	132.2	217.47	241.27	.9045
100	180.9	229.67	255.00	.9593	140.2	229.45	254.69	.9414
	2.0 bars (−12.53°C)				2.4 bars (−7.42°C)			
Sat.	83.5	165.37	182.07	0.703[illegible]	70.3	167.45	184.32	0.7004
0	88.6	172.08	189.80	.7325	72.9	171.49	188.99	.7177
10	92.6	177.50	196.02	.7548	76.3	176.98	195.29	.7404
20	96.4	183.00	202.28	.7766	79.6	182.53	201.63	.7624
30	100.2	188.56	208.60	.7978	82.8	188.14	208.01	.7838
40	104.0	194.17	214.97	.8184	86.0	193.80	214.44	.8047
50	107.7	199.86	221.40	.8387	89.2	199.51	220.92	.8251
60	111.4	205.62	227.90	.8585	92.3	205.31	227.46	.8450
80	118.7	217.35	241.09	.8969	98.5	217.07	240.71	.8836
100	125.9	229.35	254.53	.9339	104.5	229.12	254.20	.9208
120	133.1	241.59	268.23	.9696	110.5	241.41	267.93	.9566

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Table A-18M (*Continued*)

Temp. °C	*v*	*u*	*h*	*s*	*v*	*u*	*h*	*s*
	2.8 bars (−2.93°C)				3.2 bars (1.11°C)			
Sat.	60.76	169.26	186.27	0.6980	53.51	170.88	188.00	0.6960
0	61.66	170.89	188.15	.7049				
10	64.64	176.45	194.55	.7279	55.90	175.90	193.79	0.7167
20	67.55	182.06	200.97	.7502	58.52	181.57	200.30	.7393
30	70.40	187.71	207.42	.7718	61.06	187.28	206.82	.7612
40	73.19	193.42	213.91	.7928	63.55	193.02	213.36	.7824
50	75.94	199.18	220.44	.8134	66.00	198.82	219.94	.8031
60	78.65	205.00	227.02	.8334	68.41	204.68	226.57	.8233
80	83.99	216.82	240.34	.8722	73.14	216.55	239.96	.8623
100	89.24	228.89	253.88	.9095	77.78	228.66	253.55	.8997
120	94.43	241.21	267.65	.9455	82.36	241.00	267.36	.9358
	4.0 bars (8.15°C)				5.0 bars (15.60°C)			
Sat.	43.21	173.69	190.97	0.6928	34.82	176.61	194.02	0.6899
10	43.63	174.76	192.21	.6972				
20	45.84	180.57	198.91	.7204	35.65	179.26	197.08	0.7004
30	47.97	186.39	205.58	.7428	37.46	185.23	203.96	.7235
40	50.05	192.23	212.25	.7645	39.22	191.20	210.81	.7457
50	52.07	198.11	218.94	.7855	40.91	197.19	217.64	.7672
60	54.06	204.03	225.65	.8060	42.57	203.20	224.48	.7881
80	57.91	216.03	239.19	.8454	45.78	215.32	238.21	.8281
100	61.73	228.20	252.89	.8831	48.89	227.61	252.05	.8662
120	65.46	240.61	266.79	.9194	51.93	240.10	266.06	.9028
140	69.13	253.23	280.88	.9544	54.92	252.77	280.23	.9379
	6.0 bars (22.00°C)				7.0 bars (27.65°C)			
Sat.	29.13	179.09	196.57	0.6878	25.01	181.23	198.74	0.6860
30	30.42	184.01	202.26	.7068	25.35	182.72	200.46	.6917
40	31.97	190.13	209.31	.7297	26.76	189.00	207.73	.7153
50	33.45	196.23	216.30	.7516	28.10	195.23	214.90	.7378
60	34.89	202.34	223.27	.7729	29.39	201.45	222.02	.7595
80	37.65	214.61	237.20	.8135	31.84	213.88	236.17	.8008
100	40.32	227.01	251.20	.8520	34.19	226.40	250.33	.8398
120	42.91	239.57	265.32	.8889	36.46	239.05	264.57	.8769
140	45.45	252.31	279.58	.9243	38.67	251.85	278.92	.9125
160	47.94	265.25	294.01	.9584	40.85	264.83	293.42	.9468

Table A-18M *(Continued)*

Temp. °C	v	u	h	s	v	u	h	s
	8.0 bars (32.74°C)				9.0 bars (37.37°C)			
Sat.	21.88	183.13	200.63	0.6845	19.42	184.81	202.29	0.6832
40	22.83	187.81	206.07	.7021	19.74	186.55	204.32	.6897
50	24.07	194.19	213.45	.7253	20.91	193.10	211.92	.7136
60	25.25	200.52	220.72	.7474	22.01	199.56	219.37	.7363
80	27.48	213.13	235.11	.7894	24.07	212.37	234.03	.7790
100	29.59	225.77	249.44	.8289	26.01	225.13	248.54	.8190
120	31.62	238.51	263.81	.8664	27.85	237.97	263.03	.8569
140	33.59	251.39	278.26	.9022	29.64	250.90	277.58	.8930
160	35.52	264.41	292.83	.9367	31.38	263.99	292.23	.9276
180	37.42	277.60	307.54	.9699	33.09	277.23	307.01	.9609
	10.0 bars (41.64°C)				12.0 bars (49.31°C)			
Sat.	17.44	186.32	203.76	0.6820	14.41	188.95	206.24	0.6799
50	18.37	191.95	210.32	.7026	14.48	189.43	206.81	.6816
60	19.41	198.56	217.97	.7259	15.46	196.41	214.96	.7065
80	21.34	211.57	232.91	.7695	17.22	209.91	230.57	.7520
100	23.13	224.48	247.61	.8100	18.81	223.13	245.70	.7937
120	24.84	237.41	262.25	.8482	20.30	236.27	260.63	.8326
140	26.47	250.43	276.90	.8845	21.72	249.45	275.51	.8696
160	28.07	263.56	291.63	.9193	23.09	263.70	290.41	.9048
180	29.63	276.84	306.47	.9528	24.43	276.05	305.37	.9385
200	31.16	290.26	321.42	.9851	25.74	289.55	320.44	.9711
	14.0 bars (56.09°C)				16.0 bars (62.19°C)			
Sat.	12.22	191.11	208.22	0.6778	10.54	192.95	209.81	0.6758
60	12.58	194.00	211.61	.6881				
80	14.25	208.11	228.06	.7360	11.98	206.17	225.34	0.7209
100	15.71	221.70	243.69	.7791	13.37	220.19	241.58	.7656
120	17.05	235.09	258.96	.8189	14.61	233.84	257.22	.8065
140	18.32	248.43	274.08	.8564	15.77	247.38	272.61	.8447
160	19.54	261.80	289.16	.8921	16.86	260.90	287.88	.8808
180	20.71	275.27	304.26	.9262	17.92	274.47	303.14	.9152
200	21.86	288.84	319.44	.9589	18.95	288.11	318.43	.9482
220	22.99	302.51	334.70	.9905	19.96	301.84	333.78	.9800

Source: Based on data supplied by Freon Products Division, E. I. du Pont de Nemours & Company, 1969.

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TABLE A-7M

Properties of water—saturation-temperature table (SI units)*

v in cm³/g, 1 cm³/g = 10^{-3} m³/kg; h and u in kJ/kg; s in kJ/kg·K; p in bars, 1 bar = ~~10^5Pa~~

		Specific volume		Internal energy		Enthalpy			Entropy	
Temp. °C T	Press. bars P	Sat. liquid v_f	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	0.00611	1.0002	206278	−0.03	2375.4	0.02	2501.4	2501.3	0.0001	9.1565
5	0.00872	1.0001	147120	20.97	2382.3	20.98	2489.6	2510.6	0.0761	9.0257
10	0.01228	1.0004	106379	42.00	2389.2	42.01	2477.7	2519.8	0.1510	8.9008
15	0.01705	1.0009	77926	62.99	2396.1	62.99	2465.9	2528.9	0.2245	8.7814
20	0.02339	1.0018	57791	83.95	2402.9	83.96	2454.1	2538.1	0.2966	8.6672
25	0.03169	1.0029	43360	104.88	2409.8	104.89	2442.3	2547.2	0.3674	8.5580
30	0.04246	1.0043	32894	125.78	2416.6	125.79	2430.5	2556.3	0.4369	8.4533
35	0.05628	1.0060	25216	146.67	2423.4	146.68	2418.6	2565.3	0.5053	8.3531
40	0.07384	1.0078	19523	167.56	2430.1	167.57	2406.7	2574.3	0.5725	8.2570
45	0.09593	1.0099	15258	188.44	2436.8	188.45	2394.8	2583.2	0.6387	8.1648
50	0.1235	1.0121	12032	209.32	2443.5	209.33	2382.7	2592.1	0.7038	8.0763
55	0.1576	1.0146	9568	230.21	2450.1	230.23	2370.7	2600.9	0.7679	7.9913
60	0.1994	1.0172	7671	251.11	2456.6	251.13	2358.5	2609.6	0.8312	7.9096
65	0.2503	1.0199	6197	272.02	2463.1	272.06	2346.2	2618.3	0.8935	7.8310
70	0.3119	1.0228	5042	292.95	2469.6	292.98	2333.8	2626.8	0.9549	7.7553
75	0.3858	1.0259	4131	313.90	2475.9	313.93	2321.4	2635.3	1.0155	7.6824
80	0.4739	1.0291	3407	334.86	2482.2	334.91	2308.8	2643.7	1.0753	7.6122
85	0.5783	1.0325	2828	355.84	2488.4	355.90	2296.0	2651.9	1.1343	7.5445
90	0.7014	1.0360	2361	376.85	2494.5	376.92	2283.2	2660.1	1.1925	7.4791
95	0.8455	1.0397	1982	397.88	2500.6	397.96	2270.2	2668.1	1.2500	7.4159
100	1.014	1.0435	1673.	418.94	2506.5	419.04	2257.0	2676.1	1.3069	7.3549
110	1.433	1.0516	1210.	461.14	2518.1	461.30	2230.2	2691.5	1.4185	7.2387
120	1.985	1.0603	891.9	503.50	2529.3	503.71	2202.6	2706.3	1.5276	7.1296
130	2.701	1.0697	668.5	546.02	2539.9	546.31	2174.2	2720.5	1.6344	7.0269
140	3.613	1.0797	508.9	588.74	2550.0	589.13	2144.7	2733.9	1.7391	6.9299
150	4.758	1.0905	392.8	631.68	2559.5	632.20	2114.3	2746.5	1.8418	6.8379
160	6.178	1.1020	307.1	674.86	2568.4	675.55	2082.6	2758.1	1.9427	6.7502
170	7.917	1.1143	242.8	718.33	2576.5	719.21	2049.5	2768.7	2.0419	6.6663
180	10.02	1.1274	194.1	762.09	2583.7	763.22	2015.0	2778.2	2.1396	6.5857
190	12.54	1.1414	156.5	806.19	2590.0	807.62	1978.8	2786.4	2.2359	6.5079
200	15.54	1.1565	127.4	850.65	2595.3	852.45	1940.7	2793.2	2.3309	6.4323
210	19.06	1.1726	104.4	895.53	2599.5	897.76	1900.7	2798.5	2.4248	6.3585
220	23.18	1.1900	86.19	940.87	2602.4	943.62	1858.5	2802.1	2.5178	6.2861
230	27.95	1.2088	71.58	986.74	2603.9	990.12	1813.8	2804.0	2.6099	6.2146
240	33.44	1.2291	59.76	1033.2	2604.0	1037.3	1766.5	2803.8	2.7015	6.1437
250	39.73	1.2512	50.13	1080.4	2602.4	1085.4	1716.2	2801.5	2.7927	6.0730
260	46.88	1.2755	42.21	1128.4	2599.0	1134.4	1662.5	2796.9	2.8838	6.0019
270	54.99	1.3023	35.64	1177.4	2593.7	1184.5	1605.2	2789.7	2.9751	5.9301
280	64.12	1.3321	30.17	1227.5	2586.1	1236.0	1543.6	2779.6	3.0668	5.8571
290	74.36	1.3656	25.57	1278.9	2576.0	1289.1	1477.1	2766.2	3.1594	5.7821
300	85.81	1.4036	21.67	1332.0	2563.0	1344.0	1404.9	2749.0	3.2534	5.7045
320	112.7	1.4988	15.49	1444.6	2525.5	1461.5	1238.6	2700.1	3.4480	5.5362
340	145.9	1.6379	10.80	1570.3	2464.6	1594.2	1027.9	2622.0	3.6594	5.3357
360	186.5	1.8925	6.945	1725.2	2351.5	1760.5	720.5	2481.0	3.9147	5.0526
374.14	220.9	3.155	3.155	2029.6	2029.6	2099.3	0	2099.3	4.4298	4.4298

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* Abridged from Keenan, J. H., F. G. Keyes, P. G. Hill, and J. G. Moore, "Steam Tables," Wiley, New York, 1969.

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TABLE A-8M

Properties of water—saturation-pressure table (SI units)*

v in cm³/g, 1 cm³/g = 10^{-3} m³/kg; h and u in kJ/kg; s in kJ/kg·K; p in bars, 1 bar = 10^5 Pa

		Specific volume		Internal energy		Enthalpy			Entropy	
Press. bars P	Temp. °C T	Sat. liquid v_f	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
0.040	28.96	1.0040	34800.	121.45	2415.2	121.46	2432.9	2554.4	0.4226	8.4746
0.060	36.16	1.0064	23729.	151.53	2425.0	151.53	2415.9	2567.4	0.5210	8.3304
0.080	41.51	1.0084	18103.	173.87	2432.2	173.88	2403.1	2577.0	0.5926	8.2287
0.10	45.81	1.0102	14674.	191.82	2437.9	191.83	2392.8	2584.7	0.6493	8.1502
0.20	60.06	1.0172	7649.	251.38	2456.7	251.40	2358.3	2609.7	0.8320	7.9085
0.30	69.10	1.0223	5229.	289.20	2468.4	289.23	2336.1	2625.3	0.9439	7.7686
0.40	75.87	1.0265	3993.	317.53	2477.0	317.58	2319.2	2636.8	1.0259	7.6700
0.50	81.33	1.0300	3240.	340.44	2483.9	340.49	2305.4	2645.9	1.0910	7.5939
0.60	85.94	1.0331	2732.	359.79	2489.6	359.86	2293.6	2653.5	1.1453	7.5320
0.70	89.95	1.0360	2365.	376.63	2494.5	376.70	2283.3	2660.0	1.1919	7.4797
0.80	93.50	1.0380	2087.	391.58	2498.8	391.66	2274.1	2665.8	1.2329	7.4346
0.90	96.71	1.0410	1869.	405.06	2502.6	405.15	2265.7	2670.9	1.2695	7.3949
1.00	99.63	1.0432	1694.	417.36	2506.1	417.46	2258.0	2675.5	1.3026	7.3594
1.50	111.4	1.0528	1159.	466.94	2519.7	467.11	2226.5	2693.6	1.4336	7.2233
2.00	120.2	1.0605	885.7	504.49	2529.5	504.70	2201.9	2706.7	1.5301	7.1271
2.50	127.4	1.0672	718.7	535.10	2537.2	535.37	2181.5	2716.9	1.6072	7.0527
3.00	133.6	1.0732	605.8	561.15	2543.6	561.47	2163.8	2725.3	1.6718	6.9919
3.50	138.9	1.0786	524.3	583.95	2548.9	584.33	2148.1	2732.4	1.7275	6.9405
4.00	143.6	1.0836	462.5	604.31	2553.6	604.74	2133.8	2738.6	1.7766	6.8959
4.50	147.9	1.0882	414.0	622.77	2557.6	623.25	2120.7	2743.9	1.8207	6.8565
5.00	151.9	1.0926	374.9	639.68	2561.2	640.23	2108.5	2748.7	1.8607	6.8213
6.00	158.9	1.1006	315.7	669.90	2567.4	670.56	2086.3	2756.8	1.9312	6.7600
7.00	165.0	1.1080	272.9	696.44	2572.5	697.22	2065.3	2763.5	1.9922	6.7080
8.00	170.4	1.1148	240.4	720.22	2576.8	721.11	2048.0	2769.1	2.0462	6.6628
9.00	175.4	1.1212	215.0	741.83	2580.5	742.83	2031.1	2773.9	2.0946	6.6226
10.0	179.9	1.1273	194.4	761.68	2583.6	762.81	2015.3	2778.1	2.1387	6.5863
15.0	198.3	1.1539	131.8	843.16	2594.5	844.89	1947.3	2792.2	2.3150	6.4448
20.0	212.4	1.1767	99.63	906.44	2600.3	908.79	1890.7	2799.5	2.4474	6.3409
25.0	224.0	1.1973	79.98	959.11	2603.1	962.11	1841.0	2803.1	2.5547	6.2575
30.0	233.9	1.2165	66.68	1004.8	2604.1	1008.4	1795.7	2804.2	2.6457	6.1869
35.0	242.6	1.2347	57.07	1045.4	2603.7	1049.8	1753.7	2803.4	2.7253	6.1253
40.0	250.4	1.2522	49.78	1082.3	2602.3	1087.3	1714.1	2801.4	2.7964	6.0701
45.0	257.5	1.2692	44.06	1116.2	2600.1	1121.9	1676.4	2798.3	2.8610	6.0199
50.0	264.0	1.2859	39.44	1147.8	2597.1	1154.2	1640.1	2794.3	2.9202	5.9734
60.0	275.6	1.3187	32.44	1205.4	2589.7	1213.4	1571.0	2784.3	3.0267	5.8892
70.0	285.9	1.3513	27.37	1257.6	2580.5	1267.0	1505.1	2772.1	3.1211	5.8133
80.0	295.1	1.3842	23.52	1305.6	2569.8	1316.6	1441.3	2758.0	3.2068	5.7432
90.0	303.4	1.4178	20.48	1350.5	2557.8	1363.3	1378.9	2742.1	3.2858	5.6772
100.	311.1	1.4524	18.03	1393.0	2544.4	1407.6	1317.1	2724.7	3.3596	5.6141
110.	318.2	1.4886	15.99	1433.7	2529.8	1450.1	1255.5	2705.6	3.4295	5.5527
120.	324.8	1.5267	14.26	1473.0	2513.7	1491.3	1193.6	2684.9	3.4962	5.4924
130.	330.9	1.5671	12.78	1511.1	2496.1	1531.5	1130.7	2662.2	3.5606	5.4323
140.	336.8	1.6107	11.49	1548.6	2476.8	1571.1	1066.5	2637.6	3.6232	5.3717
150.	342.2	1.6581	10.34	1585.6	2455.5	1610.5	1000.0	2610.5	3.6848	5.3098
160.	347.4	1.7107	9.306	1622.7	2431.7	1650.1	930.6	2580.6	3.7451	5.2455
170.	352.4	1.7702	8.364	1660.2	2405.0	1690.3	856.9	2547.2	3.8079	5.1777
180.	357.1	1.8397	7.489	1698.9	2374.3	1732.0	777.1	2509.1	3.8715	5.1044
190.	361.5	1.9243	6.657	1739.9	2338.1	1776.5	688.0	2464.5	3.9388	5.0228
200.	365.8	2.036	5.834	1785.6	2293.0	1826.3	583.4	2409.7	4.0139	4.9269
220.9	374.1	3.155	3.155	2029.6	2029.6	2099.3	0	2099.3	4.4298	4.4298

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* Abridged from Keenan et al., "Steam Tables," Wiley, New York, 1969.

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APPENDIX 729

TABLE A-9M

Properties of water—superheated vapor (SI units)*

v in cm³/g, 1 cm³/g = 10^{-3} m³/kg; h and u in kJ/kg; s in kJ/kg·K

Temp. °C	v	u	h	s	v	u	h	s
	6 kPa (36.16°C)				35 kPa (72.69°C)			
Sat.	23739	2425.0	2546.4	8.3304	4526.	2473.0	2631.4	7.7158
80	27132	2487.3	2650.1	8.5804	4625.	2483.7	2645.6	7.7564
120	30219	2544.7	2726.0	8.7840	5163.	2542.4	2723.1	7.9644
160	33302	2602.7	2802.5	8.9693	5696.	2601.2	2800.6	8.1519
200	36383	2661.4	2879.7	9.1398	6228.	2660.4	2878.4	8.3237
240	39462	2721.0	2957.8	9.2982	6758.	2720.3	2956.8	8.4828
280	42540	2781.5	3036.8	9.4464	7287.	2780.9	3036.0	8.6314
320	45618	2843.0	3116.7	9.5859	7815.	2842.5	3116.1	8.7712
360	48696	2905.5	3197.7	9.7180	8344.	2905.1	3197.1	8.9034
400	51774	2969.0	3279.6	9.8435	8872.	2968.6	3279.2	9.0291
440	54851	3033.5	3362.6	9.9633	9400.	3033.2	3362.2	9.1490
500	59467	3132.3	3489.1	10.134	10192.	3132.1	3488.8	9.3194
	70 kPa (89.95°C)				100 kPa (99.63°C)			
Sat.	2365.	2494.5	2660.0	7.4797	1694.	2506.1	2675.5	7.3594
100	2434.	2509.7	2680.0	7.5341	1696.	2506.7	2676.2	7.3614
120	2571.	2539.7	2719.6	7.6375	1793.	2537.3	2716.6	7.4668
160	2841.	2599.4	2798.2	7.8279	1984.	2597.8	2796.2	7.6597
200	3108.	2659.1	2876.7	8.0012	2172.	2658.1	2875.3	7.8343
240	3374.	2719.3	2955.5	8.1611	2359.	2718.5	2954.5	7.9949
280	3640.	2780.2	3035.0	8.3162	2546.	2779.6	3034.2	8.1445
320	3905.	2842.0	3115.3	8.4504	2732.	2841.5	3114.6	8.2849
360	4170.	2904.6	3196.5	8.5828	2917.	2904.2	3195.9	8.4175
400	4434.	2968.2	3278.6	8.7086	3103.	2967.9	3278.2	8.5435
440	4698.	3032.9	3361.8	8.8286	3288.	3032.6	3361.4	8.6636
500	5095.	3131.8	3488.5	8.9991	3565.	3131.6	3488.1	8.8342
	150 kPa (111.37°C)				300 kPa (133.55°C)			
Sat.	1159.	2519.7	2693.6	7.2233	606.	2543.6	2725.3	6.9919
120	1188.	2533.3	2711.4	7.2693				
160	1317.	2595.2	2792.8	7.4665	651.	2587.1	2782.3	7.1276
200	1444.	2656.2	2872.9	7.6433	716.	2650.7	2865.5	7.3115
240	1570.	2717.2	2952.7	7.8052	781.	2713.1	2947.3	7.4774
280	1695.	2778.6	3032.8	7.9555	844.	2775.4	3028.6	7.6299
320	1819.	2840.6	3113.5	8.0964	907.	2838.1	3110.1	7.7722
360	1943.	2903.5	3195.0	8.2293	969.	2901.4	3192.2	7.9061
400	2067.	2967.3	3277.4	8.3555	1032.	2965.6	3275.0	8.0330
440	2191.	3032.1	3360.7	8.4757	1094.	3030.6	3358.7	8.1538
500	2376.	3131.2	3487.6	8.6466	1187.	3130.0	3486.0	8.3251
600	2685.	3301.7	3704.3	8.9101	1341.	3300.8	3703.2	8.5892

* Abridged from Keenan, J. H., F. G. Keyes, P. G. Hill, and J. G. Moore, "Steam Tables," Wiley, New York, 1969.

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TABLE A-9M
(Continued)

Temp. °C	v	u	h	s	v	u	h	s
	500 kPa (151.86°C)				700 kPa (164.97°C)			
Sat.	374.9	2561.2	2748.7	6.8213	272.9	2572.5	2763.5	6.7080
180	404.5	2609.7	2812.0	6.9656	284.7	2599.8	2799.1	6.7880
200	424.9	2642.9	2855.4	7.0592	299.9	2634.8	2844.8	6.8865
240	464.6	2707.6	2939.9	7.2307	329.2	2701.8	2932.2	7.0641
280	503.4	2771.2	3022.9	7.3865	357.4	2766.9	3017.1	7.2233
320	541.6	2834.7	3105.6	7.5308	385.2	2831.3	3100.9	7.3697
360	579.6	2898.7	3188.4	7.6660	412.6	2895.8	3184.7	7.5063
400	617.3	2963.2	3271.9	7.7938	439.7	2960.9	3268.7	7.6350
440	654.8	3028.6	3356.0	7.9152	466.7	3026.6	3353.3	7.7571
500	710.9	3128.4	3483.9	8.0873	507.0	3126.8	3481.7	7.9290
600	804.1	3299.6	3701.7	8.3522	573.8	3298.5	3700.2	8.1956
700	896.9	3477.5	3925.9	8.5952	640.3	3476.6	3924.8	8.4391
	1.0 MPa (179.91°C)				1.5 MPa (198.32°C)			
Sat.	194.4	2583.6	2778.1	6.5865	131.8	2594.5	2792.2	6.4448
200	206.0	2621.9	2827.9	6.6940	132.5	2598.1	2796.8	6.4546
240	227.5	2692.9	2920.4	6.8817	148.3	2676.9	2899.3	6.6628
280	248.0	2760.2	3008.2	7.0465	162.7	2748.6	2992.7	6.8381
320	267.8	2826.1	3093.9	7.1962	176.5	2817.1	3081.9	6.9938
360	287.3	2891.6	3178.9	7.3349	189.9	2884.4	3169.2	7.1363
400	306.6	2957.3	3263.9	7.4651	203.0	2951.3	3255.8	7.2690
440	325.7	3023.6	3349.3	7.5883	216.0	3018.5	3342.5	7.3940
500	354.1	3124.4	3478.5	7.7622	235.2	3120.3	3473.1	7.5698
540	372.9	3192.6	3565.6	7.8720	247.8	3189.1	3560.9	7.6805
600	401.1	3296.8	3697.9	8.0290	266.8	3293.9	3694.0	7.8385
640	419.8	3367.4	3787.2	8.1290	279.3	3364.8	3783.8	7.9391
	2.0 MPa (212.42°C)				3.0 MPa (233.90°C)			
Sat.	99.6	2600.3	2799.5	6.3409	66.7	2604.1	2804.2	6.1869
240	108.5	2659.6	2876.5	6.4952	68.2	2619.7	2824.3	6.2265
280	120.0	2736.4	2976.4	6.6828	77.1	2709.9	2941.3	6.4462
320	130.8	2807.9	3069.5	6.8452	85.0	2788.4	3043.4	6.6245
360	141.1	2877.0	3159.3	6.9917	92.3	2861.7	3138.7	6.7801
400	151.2	2945.2	3247.6	7.1271	99.4	2932.8	3230.9	6.9212
440	161.1	3013.4	3335.5	7.2540	106.2	3002.9	3321.5	7.0520
500	175.7	3116.2	3467.6	7.4317	116.2	3108.0	3456.5	7.2338
540	185.3	3185.6	3556.1	7.5434	122.7	3178.4	3546.6	7.3474
600	199.6	3290.9	3690.1	7.7024	132.4	3285.0	3682.3	7.5085
640	209.1	3362.2	3780.4	7.8035	138.8	3357.0	3773.5	7.6104
700	223.2	3470.9	3917.4	7.9487	148.4	3466.5	3911.7	7.7571

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TABLE A-9M
(Continued)

Temp. °C	v	u	h	s	v	u	h	s
	4.0 MPa (250.40°C)				6.0 MPa (275.64°C)			
Sat.	49.78	2602.3	2801.4	6.0701	32.44	2589.7	2784.3	5.8892
280	55.46	2680.0	2901.8	6.2568	33.17	2605.2	2804.2	5.9252
320	61.99	2767.4	3015.4	6.4553	38.76	2720.0	2952.6	6.1846
360	67.88	2845.7	3117.2	6.6215	43.31	2811.2	3071.1	6.3782
400	73.41	2919.9	3213.6	6.7690	47.39	2892.9	3177.2	6.5408
440	78.72	2992.2	3307.1	6.9041	51.22	2970.0	3277.3	6.6853
500	86.43	3099.5	3445.3	7.0901	56.65	3082.2	3422.2	6.8803
540	91.45	3171.1	3536.9	7.2055	60.15	3156.1	3517.0	6.9999
600	98.85	3279.1	3674.4	7.3688	65.25	3266.9	3658.4	7.1677
640	103.7	3351.8	3766.6	7.4720	68.59	3341.0	3752.6	7.2731
700	111.0	3462.1	3905.9	7.6198	73.52	3453.1	3894.1	7.4234
740	115.7	3536.6	3999.6	7.7141	76.77	3528.3	3989.2	7.5190
	8.0 MPa (295.06°C)				10.0 MPa (311.06°C)			
Sat.	23.52	2569.8	2758.0	5.7432	18.03	2544.4	2724.7	5.6141
320	26.82	2662.7	2877.2	5.9489	19.25	2588.8	2781.3	5.7103
360	30.89	2772.7	3019.8	6.1819	23.31	2729.1	2962.1	6.0060
400	34.32	2863.8	3138.3	6.3634	26.41	2832.4	3096.5	6.2120
440	37.42	2946.7	3246.1	6.5190	29.11	2922.1	3213.2	6.3805
480	40.34	3025.7	3348.4	6.6585	31.60	3005.4	3321.4	6.5282
520	43.13	3102.7	3447.7	6.7871	33.94	3085.6	3425.1	6.6622
560	45.82	3178.7	3545.3	6.9072	36.19	3164.1	3526.0	6.7864
600	48.45	3254.4	3642.0	7.0205	38.37	3241.7	3625.3	6.9029
640	51.02	3330.1	3738.3	7.1283	40.48	3318.9	3723.7	7.0131
700	54.81	3443.9	3882.4	7.2812	43.58	3434.7	3870.5	7.1687
740	57.29	3520.4	3978.7	7.3782	45.60	3512.1	3968.1	7.2670
	12.0 MPa (324.75°C)				14.0 MPa (336.75°C)			
Sat.	14.26	2513.7	2684.9	5.4924	11.49	2476.8	2637.6	5.3717
360	18.11	2673.4	2895.7	5.8351	14.22	2617.4	2816.5	5.6602
400	21.08	2798.3	3051.3	6.0747	17.22	2760.9	3001.9	5.9448
440	23.55	2896.1	3178.7	6.2586	19.54	2868.6	3142.2	6.1474
480	25.76	2984.4	3293.5	6.4154	21.57	2962.5	3264.5	6.3143
520	27.81	3068.0	3401.8	6.5555	23.43	3049.8	3377.8	6.4610
560	29.77	3149.0	3506.2	6.6840	25.17	3133.6	3486.0	6.5941
600	31.64	3228.7	3608.3	6.8037	26.83	3215.4	3591.1	6.7172
640	33.45	3307.5	3709.0	6.9164	28.43	3296.0	3694.1	6.8326
700	36.10	3425.2	3858.4	7.0749	30.75	3415.7	3846.2	6.9939
740	37.81	3503.7	3957.4	7.1746	32.25	3495.2	3946.7	7.0952

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732 APPENDIX

TABLE A-9M
(Continued)

Temp. °C	v	u	h	s	v	u	h	s
	16.0 MPa (347.44°C)				18.0 MPa (357.06°C)			
Sat.	9.31	2431.7	2580.6	5.2455	7.49	2374.3	2509.1	5.1044
360	11.05	2539.0	2715.8	5.4614	8.09	2418.9	2564.5	5.1922
400	14.26	2719.4	2947.6	5.8175	11.90	2672.8	2887.0	5.6887
440	16.52	2839.4	3103.7	6.0429	14.14	2808.2	3062.8	5.9428
480	18.42	2939.7	3234.4	6.2215	15.96	2915.9	3203.2	6.1343
520	20.13	3031.1	3353.3	6.3752	17.57	3011.8	3378.0	6.2960
560	21.72	3117.8	3465.4	6.5132	19.04	3101.7	3444.4	6.4392
600	23.23	3201.8	3573.5	6.6399	20.42	3188.0	3555.6	6.5696
640	24.67	3284.2	3678.9	6.7580	21.74	3272.3	3663.6	6.6903
700	26.74	3406.0	3833.9	6.9224	23.62	3396.3	3821.5	6.8580
740	28.08	3486.7	3935.9	7.0251	24.83	3478.0	3925.0	6.9623
	20.0 MPa (365.81°C)				24.0 MPa			
Sat.	5.83	2293.0	2409.7	4.9269				
400	9.94	2619.3	2818.1	5.5540	6.73	2477.8	2639.4	5.2393
440	12.22	2774.9	3019.4	5.8450	9.29	2700.6	2923.4	5.6506
480	13.99	2891.2	3170.8	6.0518	11.00	2838.3	3102.3	5.8950
520	15.51	2992.0	3302.2	6.2218	12.41	2950.5	3248.5	6.0842
560	16.89	3085.2	3423.0	6.3705	13.66	3051.1	3379.0	6.2448
600	18.18	3174.0	3537.6	6.5048	14.81	3145.2	3500.7	6.3875
640	19.40	3260.2	3648.1	6.6286	15.88	3235.5	3616.7	6.5174
700	21.13	3386.4	3809.0	6.7993	17.39	3366.4	3783.8	6.6947
740	22.24	3469.3	3914.1	6.9052	18.35	3451.7	3892.1	6.8038
800	23.85	3592.7	4069.7	7.0544	19.74	3578.0	4051.6	6.9567
	28.0 MPa				32.0 MPa			
400	3.83	2223.5	2330.7	4.7494	2.36	1980.4	2055.9	4.3239
440	7.12	2613.2	2812.6	5.4494	5.44	2509.0	2683.0	5.2327
480	8.85	2780.8	3028.5	5.7446	7.22	2718.1	2949.2	5.5968
520	10.20	2906.8	3192.3	5.9566	8.53	2860.7	3133.7	5.8357
560	11.36	3015.7	3333.7	6.1307	9.63	2979.0	3287.2	6.0246
600	12.41	3115.6	3463.0	6.2823	10.61	3085.3	3424.6	6.1851
640	13.38	3210.3	3584.8	6.4187	11.50	3184.5	3552.5	6.3290
700	14.73	3346.1	3758.4	6.6029	12.73	3325.4	3732.8	6.5203
740	15.58	3433.9	3870.0	6.7153	13.50	3415.9	3847.8	6.6361
800	16.80	3563.1	4033.4	6.8720	14.60	3548.0	4015.1	6.7966
900	18.73	3774.3	4298.8	7.1084	16.33	3762.7	4285.1	7.0372

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TABLE A-10M.

Properties of water—compressed-liquid table (SI units)*

v in cm³/g, 1 cm³/g = 10^{-3} m³/kg; h and u in kJ/kg; s in kJ/kg·K

Temp. C	v	u	h	s	v	u	h	s
	2.5 MPa (223.99°C)				5.0 MPa (263.99°C)			
20	1.0006	83.80	86.30	0.2961	0.9995	83.65	88.65	0.2956
40	1.0067	167.25	169.77	0.5715	1.0056	166.95	171.97	0.5705
80	1.0280	334.29	336.86	1.0737	1.0268	333.72	338.85	1.0720
120	1.0590	502.68	505.33	1.5255	1.0576	501.80	507.09	1.5233
160	1.1006	673.90	676.65	1.9404	1.0988	672.62	678.12	1.9375
200	1.1555	849.9	852.8	2.3294	1.1530	848.1	848.1	2.3255
220	1.1898	940.7	943.7	2.5174	1.1866	938.4	944.4	2.5128
Sat.	1.1973	959.1	962.1	2.5546	1.2859	1147.8	1154.2	2.9202
	7.5 MPa (290.59°C)				10.0 MPa (311.06°C)			
20	0.9984	83.50	90.99	0.2950	0.9972	83.36	93.33	0.2945
40	1.0045	166.64	174.18	0.5696	1.0034	166.35	176.38	0.5686
80	1.0256	333.15	340.84	1.0704	1.0245	332.59	342.83	1.0688
100	1.0397	416.81	424.62	1.3011	1.0385	416.12	426.50	1.2992
140	1.0752	585.72	593.78	1.7317	1.0737	584.68	595.42	1.7292
180	1.1219	758.13	766.55	2.1308	1.1199	756.65	767.84	2.1275
220	1.1835	936.2	945.1	2.5083	1.1805	934.1	945.9	2.5039
260	1.2696	1124.4	1134.0	2.8763	1.2645	1121.1	1133.7	2.8699
Sat.	1.3677	1282.0	1292.2	3.1649	1.4524	1393.0	1407.6	3.3596
	15.0 MPa (342.24°C)				20.0 MPa (365.81°C)			
20	0.9950	83.06	97.99	0.2934	0.9928	82.77	102.62	0.2923
40	1.0013	165.76	180.78	0.5666	0.9992	165.17	185.16	0.5646
100	1.0361	414.75	430.28	1.2955	1.0337	413.39	434.06	1.2911
180	1.1159	753.76	770.50	2.1210	1.1120	750.95	773.20	2.1141
220	1.1748	929.9	947.5	2.4953	1.1693	925.9	949.3	2.4870
260	1.2550	1114.6	1133.4	2.8576	1.2462	1108.6	1133.5	2.8459
300	1.3770	1316.6	1337.3	3.2260	1.3596	1306.1	1333.3	3.2071
Sat.	1.6581	1585.6	1610.5	3.6848	2.036	1785.6	1826.3	4.0139
	25.0 MPa				30.0 MPa			
20	0.9907	82.47	107.24	0.2911	0.9886	82.17	111.84	0.2899
40	0.9971	164.60	189.52	0.5626	0.9951	164.04	193.89	0.5607
100	1.0313	412.08	437.85	1.2881	1.0290	410.78	441.66	1.2844
200	1.1344	834.5	862.8	2.2961	1.1302	831.4	865.3	2.2893
300	1.3442	1296.6	1330.2	3.1900	1.3304	1287.9	1327.8	3.1741

* Abridged from Keenan, J. H., F. G. Keyes, P. G. Hill, and J. G. Moore, "Steam Tables," Wiley, New York, 1969.

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