

**9209-515 Source document:
Refrigeration and Air Tables**

Candidates should familiarise themselves with this document throughout the course and will need to refer to a clean copy of this document in the exam and for the sample questions..

TABLE A-13

Superheated refrigerant-134a

T °C	$P = 0.06 \text{ MPa } (T_{\text{sat}} = -36.95^\circ\text{C})$				$P = 0.10 \text{ MPa } (T_{\text{sat}} = -26.37^\circ\text{C})$				$P = 0.14 \text{ MPa } (T_{\text{sat}} = -18.77^\circ\text{C})$			
	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K
Sat.	0.31121	209.12	227.79	0.9644	0.19254	215.19	234.44	0.9518	0.14014	219.54	239.16	0.9446
-20	0.33608	220.60	240.76	1.0174	0.19841	219.66	239.50	0.9721				
-10	0.35048	227.55	248.58	1.0477	0.20743	226.75	247.49	1.0030	0.14605	225.91	246.36	0.9724
0	0.36476	234.66	256.54	1.0774	0.21630	233.95	255.58	1.0332	0.15263	233.23	254.60	1.0031
10	0.37893	241.92	264.66	1.1066	0.22506	241.30	263.81	1.0628	0.15908	240.66	262.93	1.0331
20	0.39302	249.35	272.94	1.1353	0.23373	248.79	272.17	1.0918	0.16544	248.22	271.38	1.0624
30	0.40705	256.95	281.37	1.1636	0.24233	256.44	280.68	1.1203	0.17172	255.93	279.97	1.0912
40	0.42102	264.71	289.97	1.1915	0.25088	264.25	289.34	1.1484	0.17794	263.79	288.70	1.1195
50	0.43495	272.64	298.74	1.2191	0.25937	272.22	298.16	1.1762	0.18412	271.79	297.57	1.1474
60	0.44883	280.73	307.66	1.2463	0.26783	280.35	307.13	1.2035	0.19025	279.96	306.69	1.1749
70	0.46269	288.99	316.75	1.2732	0.27626	288.64	316.26	1.2305	0.19635	288.28	315.77	1.2020
80	0.47651	297.41	326.00	1.2997	0.28465	297.08	325.55	1.2572	0.20242	296.75	325.09	1.2288
90	0.49032	306.00	335.42	1.3260	0.29303	305.69	334.99	1.2836	0.20847	305.38	334.57	1.2553
100	0.50410	314.74	344.99	1.3520	0.30138	314.46	344.60	1.3096	0.21449	314.17	344.20	1.2814
<hr/>												
$P = 0.18 \text{ MPa } (T_{\text{sat}} = -12.73^\circ\text{C})$ $P = 0.20 \text{ MPa } (T_{\text{sat}} = -10.09^\circ\text{C})$ $P = 0.24 \text{ MPa } (T_{\text{sat}} = -5.38^\circ\text{C})$												
Sat.	0.11041	222.99	242.86	0.9397	0.09987	224.48	244.46	0.9377	0.08390	227.14	247.28	0.9346
-10	0.11189	225.02	245.16	0.9484	0.09991	224.55	244.54	0.9380				
0	0.11722	232.48	253.58	0.9798	0.10481	232.09	253.05	0.9698	0.08617	231.29	251.97	0.9519
10	0.12240	240.00	262.04	1.0102	0.10955	239.67	261.58	1.0004	0.09026	238.98	260.65	0.9831
20	0.12748	247.64	270.59	1.0399	0.11418	247.35	270.18	1.0303	0.09423	246.74	269.36	1.0134
30	0.13248	255.41	279.25	1.0690	0.11874	255.14	278.89	1.0595	0.09812	254.61	278.16	1.0429
40	0.13741	263.31	288.05	1.0975	0.12322	263.08	287.72	1.0882	0.10193	262.59	287.06	1.0718
50	0.14230	271.36	296.98	1.1256	0.12766	271.15	296.68	1.1163	0.10570	270.71	296.08	1.1001
60	0.14715	279.56	306.05	1.1532	0.13206	279.37	305.78	1.1441	0.10942	278.97	305.23	1.1280
70	0.15196	287.91	315.27	1.1805	0.13641	287.73	315.01	1.1714	0.11310	287.36	314.51	1.1554
80	0.15673	296.42	324.63	1.2074	0.14074	296.25	324.40	1.1983	0.11675	295.91	323.93	1.1825
90	0.16149	305.07	334.14	1.2339	0.14504	304.92	333.93	1.2249	0.12038	304.60	333.49	1.2092
100	0.16622	313.88	343.80	1.2602	0.14933	313.74	343.60	1.2512	0.12398	313.44	343.20	1.2356
<hr/>												
$P = 0.28 \text{ MPa } (T_{\text{sat}} = -1.25^\circ\text{C})$ $P = 0.32 \text{ MPa } (T_{\text{sat}} = 2.46^\circ\text{C})$ $P = 0.40 \text{ MPa } (T_{\text{sat}} = 8.91^\circ\text{C})$												
Sat.	0.07235	229.46	249.72	0.9321	0.06360	231.52	251.88	0.9301	0.051201	235.07	255.55	0.9269
0	0.07282	230.44	250.83	0.9362								
10	0.07646	238.27	259.68	0.9680	0.06609	237.54	258.69	0.9544	0.051506	235.97	256.58	0.9305
20	0.07997	246.13	268.52	0.9987	0.06925	245.50	267.66	0.9856	0.054213	244.18	265.86	0.9628
30	0.08338	254.06	277.41	1.0285	0.07231	253.50	276.65	1.0157	0.056796	252.36	275.07	0.9937
40	0.08672	262.10	286.38	1.0576	0.07530	261.60	285.70	1.0451	0.059292	260.58	284.30	1.0236
50	0.09000	270.27	295.47	1.0862	0.07823	269.82	294.85	1.0739	0.061724	268.90	293.59	1.0528
60	0.09324	278.56	304.67	1.1142	0.08111	278.15	304.11	1.1021	0.064104	277.32	302.96	1.0814
70	0.09644	286.99	314.00	1.1418	0.08395	286.62	313.48	1.1298	0.066443	285.86	312.44	1.1094
80	0.09961	295.57	323.46	1.1690	0.08675	295.22	322.98	1.1571	0.068747	294.53	322.02	1.1369
90	0.10275	304.29	333.06	1.1958	0.08953	303.97	332.62	1.1840	0.071023	303.32	331.73	1.1640
100	0.10587	313.15	342.80	1.2222	0.09229	312.86	342.39	1.2105	0.073274	312.26	341.57	1.1907
110	0.10897	322.16	352.68	1.2483	0.09503	321.89	352.30	1.2367	0.075504	321.33	351.53	1.2171
120	0.11205	331.32	362.70	1.2742	0.09775	331.07	362.35	1.2626	0.077717	330.55	361.63	1.2431
130	0.11512	340.63	372.87	1.2997	0.10045	340.39	372.54	1.2882	0.079913	339.90	371.87	1.2688
140	0.11818	350.09	383.18	1.3250	0.10314	349.86	382.87	1.3135	0.082096	349.41	382.24	1.2942

TABLE A-13

Superheated refrigerant-134a (Continued)

<i>T</i> °C	<i>v</i> m ³ /kg	<i>u</i> kJ/kg	<i>h</i> kJ/kg	<i>s</i> kJ/kg · K	<i>v</i> m ³ /kg	<i>u</i> kJ/kg	<i>h</i> kJ/kg	<i>s</i> kJ/kg · K	<i>v</i> m ³ /kg	<i>u</i> kJ/kg	<i>h</i> kJ/kg	<i>s</i> kJ/kg · K
<i>P</i> = 0.50 MPa (<i>T</i> _{sat} = 15.71°C)				<i>P</i> = 0.60 MPa (<i>T</i> _{sat} = 21.55°C)				<i>P</i> = 0.70 MPa (<i>T</i> _{sat} = 26.69°C)				
Sat.	0.041118	238.75	259.30	0.9240	0.034295	241.83	262.40	0.9218	0.029361	244.48	265.03	0.9199
20	0.042115	242.40	263.46	0.9383								
30	0.044338	250.84	273.01	0.9703	0.035984	249.22	270.81	0.9499	0.029966	247.48	268.45	0.9313
40	0.046456	259.26	282.48	1.0011	0.037865	257.86	280.68	0.9916	0.031696	256.39	278.57	0.9641
50	0.048499	267.72	291.96	1.0309	0.039659	266.48	290.28	1.0121	0.033322	265.20	288.53	0.9954
60	0.050485	276.25	301.50	1.0599	0.041389	275.15	299.98	1.0417	0.034875	274.01	298.42	1.0256
70	0.052427	284.89	311.10	1.0883	0.043069	283.89	309.73	1.0705	0.036373	282.87	308.33	1.0549
80	0.054331	293.64	320.80	1.1162	0.044710	292.73	319.55	1.0987	0.037829	291.80	318.28	1.0835
90	0.056205	302.51	330.61	1.1436	0.046318	301.67	329.46	1.1264	0.039250	300.82	328.29	1.1114
100	0.058053	311.50	340.53	1.1705	0.047900	310.73	339.47	1.1536	0.040642	309.95	338.40	1.1389
110	0.059880	320.63	350.57	1.1971	0.049458	319.91	349.59	1.1803	0.042010	319.19	348.60	1.1658
120	0.061687	329.89	360.73	1.2233	0.050997	329.23	359.82	1.2067	0.043358	328.55	358.90	1.1924
130	0.063479	339.29	371.03	1.2491	0.052519	338.67	370.18	1.2327	0.044688	338.04	369.32	1.2186
140	0.065256	348.83	381.46	1.2747	0.054027	348.25	380.66	1.2584	0.046004	347.66	379.86	1.2444
150	0.067021	358.51	392.02	1.2999	0.055522	357.96	391.27	1.2838	0.047306	357.41	390.52	1.2699
160	0.068775	368.33	402.72	1.3249	0.057006	367.81	402.01	1.3088	0.048597	367.29	401.31	1.2951
<i>P</i> = 0.80 MPa (<i>T</i> _{sat} = 31.31°C)				<i>P</i> = 0.90 MPa (<i>T</i> _{sat} = 35.51°C)				<i>P</i> = 1.00 MPa (<i>T</i> _{sat} = 39.37°C)				
Sat.	0.025621	246.79	267.29	0.9183	0.022683	248.85	269.26	0.9169	0.020313	250.68	270.99	0.9156
40	0.027035	254.82	276.45	0.9480	0.023375	253.13	274.17	0.9327	0.020406	251.30	271.71	0.9179
50	0.028547	263.86	286.69	0.9802	0.024809	262.44	284.77	0.9660	0.021796	260.94	282.74	0.9525
60	0.029973	272.83	296.81	1.0110	0.026146	271.60	295.13	0.9976	0.023068	270.32	293.38	0.9850
70	0.031340	281.81	306.88	1.0408	0.027413	280.72	305.39	1.0280	0.024261	279.59	303.85	1.0160
80	0.032659	290.84	316.97	1.0698	0.028630	289.86	315.63	1.0574	0.025398	288.86	314.25	1.0458
90	0.033941	299.95	327.10	1.0981	0.029806	299.06	325.89	1.0860	0.026492	298.15	324.64	1.0748
100	0.035193	309.15	337.30	1.1258	0.030951	308.34	336.19	1.1140	0.027552	307.51	335.06	1.1031
110	0.036420	318.45	347.59	1.1530	0.032068	317.70	346.56	1.1414	0.028584	316.94	345.53	1.1308
120	0.037625	327.87	357.97	1.1798	0.033164	327.18	357.02	1.1684	0.029592	326.47	356.06	1.1580
130	0.038813	337.40	368.45	1.2061	0.034241	336.76	367.58	1.1949	0.030581	336.11	366.69	1.1846
140	0.039985	347.06	379.05	1.2321	0.035302	346.46	378.23	1.2210	0.031554	345.85	377.40	1.2109
150	0.041143	356.85	389.76	1.2577	0.036349	356.28	389.00	1.2467	0.032512	355.71	388.22	1.2368
160	0.042290	366.76	400.59	1.2830	0.037384	366.23	399.88	1.2721	0.033457	365.70	399.15	1.2623
170	0.043427	376.81	411.55	1.3080	0.038408	376.31	410.88	1.2972	0.034392	375.81	410.20	1.2875
180	0.044554	386.99	422.64	1.3327	0.039423	386.52	422.00	1.3221	0.035317	386.04	421.36	1.3124
<i>P</i> = 1.20 MPa (<i>T</i> _{sat} = 46.29°C)				<i>P</i> = 1.40 MPa (<i>T</i> _{sat} = 52.40°C)				<i>P</i> = 1.60 MPa (<i>T</i> _{sat} = 57.88°C)				
Sat.	0.016715	253.81	273.87	0.9130	0.014107	256.37	276.12	0.9105	0.012123	258.47	277.86	0.9078
50	0.017201	257.63	278.27	0.9267								
60	0.018404	267.56	289.64	0.9614	0.015005	264.46	285.47	0.9389	0.012372	260.89	280.69	0.9163
70	0.019502	277.21	300.61	0.9938	0.016060	274.62	297.10	0.9733	0.013430	271.76	293.25	0.9535
80	0.020529	286.75	311.39	1.0248	0.017023	284.51	308.34	1.0056	0.014362	282.09	305.07	0.9875
90	0.021506	296.26	322.07	1.0546	0.017923	294.28	319.37	1.0364	0.015215	292.17	316.52	1.0194
100	0.022442	305.80	332.73	1.0836	0.018778	304.01	330.30	1.0661	0.016014	302.14	327.76	1.0500
110	0.023348	315.38	343.40	1.1118	0.019597	313.76	341.19	1.0949	0.016773	312.07	338.91	1.0795
120	0.024228	325.03	354.11	1.1394	0.020388	323.55	352.09	1.1230	0.017500	322.02	350.02	1.1081
130	0.025086	334.77	364.88	1.1664	0.021155	333.41	363.02	1.1504	0.018201	332.00	361.12	1.1360
140	0.025927	344.61	375.72	1.1930	0.021904	343.34	374.01	1.1773	0.018882	342.05	372.26	1.1632
150	0.026753	354.56	386.66	1.2192	0.022636	353.37	385.07	1.2038	0.019545	352.17	383.44	1.1900
160	0.027566	364.61	397.69	1.2449	0.023355	363.51	396.20	1.2298	0.020194	362.38	394.69	1.2163
170	0.028367	374.78	408.82	1.2703	0.024061	373.75	407.43	1.2554	0.020830	372.69	406.02	1.2421
180	0.029158	385.08	420.07	1.2954	0.024757	384.10	418.76	1.2807	0.021456	383.11	417.44	1.2676

Ideal Gas Properties of Nitrogen at Low Pressure (SI)

T °C	u kJ/kg	h kJ/kg	s° kJ/(kg · K)	P°	v°	c_p kJ/(kg · K)	c_v kJ/(kg · K)	k
-200	54.31	76.04	5.3795	0.0074	28,801.	1.0395	0.7425	1.4000
-150	91.44	128.01	5.9210	0.0461	7,822.2	1.0395	0.7425	1.4000
-100	128.56	179.99	6.2752	0.1521	3,334.4	1.0395	0.7425	1.4000
-50	165.72	231.99	6.5392	0.3702	1,765.7	1.0398	0.7428	1.3998
0	202.86	283.99	6.7494	0.7517	1,064.4	1.0400	0.7430	1.3997
25	221.44	309.99	6.8405	1.0218	854.74	1.0403	0.7433	1.3996
50	240.03	336.01	6.9243	1.3550	698.56	1.0409	0.7439	1.3993
100	277.27	388.10	7.0742	2.2452	486.83	1.0430	0.7460	1.3981
150	314.66	440.34	7.2055	3.4953	354.62	1.0468	0.7498	1.3961
200	352.29	492.82	7.3227	5.1880	267.15	1.0527	0.7557	1.3930
250	390.26	545.64	7.4289	7.4179	206.58	1.0605	0.7635	1.3890
300	428.67	598.89	7.5261	10.293	163.11	1.0699	0.7729	1.3842
350	467.58	652.65	7.6160	13.935	130.99	1.0806	0.7836	1.3790
400	507.05	706.97	7.6998	18.484	106.68	1.0922	0.7952	1.3735
450	547.10	761.88	7.7785	24.094	87.916	1.1042	0.8072	1.3679
500	587.77	817.39	7.8527	30.940	73.197	1.1163	0.8193	1.3625
550	629.03	873.51	7.9231	39.213	61.489	1.1284	0.8314	1.3572
600	670.90	930.22	7.9900	49.124	52.064	1.1401	0.8431	1.3523
650	713.34	987.52	8.0538	60.906	44.398	1.1515	0.8545	1.3476
700	756.34	1,045.4	8.1148	74.808	38.105	1.1623	0.8653	1.3432
750	799.86	1,103.7	8.1733	91.104	32.897	1.1726	0.8756	1.3392
800	843.89	1,162.6	8.2294	110.09	28.554	1.1824	0.8854	1.3355
850	888.39	1,222.0	8.2835	132.08	24.909	1.1915	0.8945	1.3320
900	933.34	1,281.8	8.3356	157.42	21.830	1.2002	0.9032	1.3288
950	978.70	1,342.0	8.3859	186.47	19.215	1.2082	0.9112	1.3259
1,000	1,024.5	1,402.6	8.4344	219.61	16.982	1.2158	0.9188	1.3232
1,100	1,117.0	1,524.9	8.5269	299.87	13.413	1.2295	0.9325	1.3185
1,200	1,210.9	1,648.4	8.6137	401.81	10.739	1.2415	0.9445	1.3145
1,300	1,305.9	1,773.1	8.6956	529.47	8.7032	1.2520	0.9550	1.3110
1,400	1,401.8	1,898.8	8.7730	687.32	7.1306	1.2612	0.9642	1.3080
1,500	1,498.7	2,025.3	8.8465	880.31	5.9001	1.2693	0.9723	1.3055
1,600	1,596.3	2,152.6	8.9163	1,113.9	4.9260	1.2765	0.9795	1.3032
1,700	1,694.6	2,280.6	8.9827	1,393.9	4.1466	1.2829	0.9859	1.3013
1,800	1,793.4	2,409.2	9.0465	1,726.8	3.5168	1.2886	0.9916	1.2995
1,900	1,892.9	2,538.3	9.1073	2,119.5	3.0033	1.2937	0.9967	1.2980
2,000	1,992.8	2,667.9	9.1656	2,579.6	2.5812	1.2983	1.0013	1.2966
2,100	2,093.1	2,797.9	9.2216	3,115.0	2.2315	1.3025	1.0055	1.2954
2,200	2,193.8	2,928.4	9.2754	3,734.6	1.9398	1.3062	1.0092	1.2943
2,300	2,294.9	3,059.2	9.3273	4,447.4	1.6947	1.3097	1.0127	1.2933
2,400	2,396.4	3,190.3	9.3773	5,263.4	1.4877	1.3129	1.0159	1.2924
2,500	2,498.1	3,321.7	9.4255	6,193.0	1.3117	1.3158	1.0188	1.2915

Ideal Gas Properties of Air at Low Pressure (SI)

T °C	u kJ/kg	h kJ/kg	s^0 kJ/(kg · K)	P^0	v^0	c_p kJ/(kg · K)	c_v kJ/(kg · K)	k
-200	52.32	73.33	5.2906	0.0101	20,488.	1.0025	0.7152	1.4016
-150	88.09	123.46	5.8128	0.0624	5,592.1	1.0025	0.7153	1.4015
-100	123.85	173.58	6.1544	0.2051	2,391.5	1.0026	0.7153	1.4015
-50	159.65	223.74	6.4090	0.4979	1,269.6	1.0030	0.7158	1.4013
0	195.46	273.92	6.6119	1.0095	766.52	1.0041	0.7169	1.4007
25	213.40	299.03	6.6999	1.3715	615.80	1.0051	0.7179	1.4001
50	231.36	324.18	6.7808	1.8186	503.36	1.0065	0.7193	1.3993
100	267.42	374.60	6.9259	3.0147	350.63	1.0107	0.7235	1.3970
150	303.74	425.28	7.0533	4.6998	255.05	1.0169	0.7296	1.3937
200	340.42	476.32	7.1673	6.9913	191.71	1.0249	0.7376	1.3894
250	377.54	527.80	7.2707	10.024	147.85	1.0345	0.7472	1.3844
300	415.17	579.79	7.3656	13.952	116.37	1.0452	0.7580	1.3789
350	453.36	632.34	7.4535	18.950	93.152	1.0568	0.7695	1.3732
400	492.13	685.48	7.5356	25.218	75.617	1.0687	0.7815	1.3675
450	531.51	739.22	7.6126	32.977	62.120	1.0808	0.7935	1.3620
500	571.49	793.56	7.6852	42.475	51.563	1.0927	0.8054	1.3566
550	612.06	848.49	7.7540	53.987	43.192	1.1042	0.8170	1.3516
600	653.19	903.98	7.8195	67.812	36.475	1.1154	0.8281	1.3468
650	694.87	960.02	7.8819	84.280	31.028	1.1260	0.8388	1.3424
700	737.07	1,016.6	7.9415	103.75	26.571	1.1360	0.8488	1.3384
750	779.75	1,073.6	7.9987	126.61	22.892	1.1455	0.8583	1.3346
800	822.89	1,131.1	8.0536	153.28	19.883	1.1544	0.8672	1.3312
850	866.47	1,189.1	8.1063	184.21	17.271	1.1628	0.8756	1.3280
900	910.45	1,247.4	8.1571	219.89	15.113	1.1706	0.8834	1.3251
950	954.81	1,306.1	8.2062	260.84	13.284	1.1779	0.8907	1.3225
1,000	999.52	1,365.2	8.2535	307.60	11.725	1.1848	0.8976	1.3200
1,100	1,088.6	1,483.0	8.3436	420.98	9.2400	1.1973	0.9101	1.3156
1,200	1,181.5	1,604.6	8.4281	565.19	7.3836	1.2083	0.9210	1.3118
1,300	1,274.1	1,726.0	8.5078	746.01	5.9736	1.2180	0.9308	1.3086
1,400	1,367.7	1,848.2	8.5831	969.91	4.8867	1.2267	0.9395	1.3057
1,500	1,462.0	1,971.3	8.6546	1,244.0	4.0377	1.2345	0.9473	1.3032
1,600	1,557.1	2,095.1	8.7225	1,576.1	3.3666	1.2416	0.9544	1.3010
1,700	1,652.9	2,219.6	8.7872	1,974.9	2.8302	1.2480	0.9608	1.2989
1,800	1,749.3	2,344.7	8.8491	2,449.8	2.3972	1.2539	0.9667	1.2971
1,900	1,846.2	2,470.4	8.9083	3,011.0	2.0446	1.2593	0.9721	1.2955
2,000	1,943.7	2,596.6	8.9650	3,669.4	1.7549	1.2644	0.9771	1.2939
2,100	2,041.7	2,723.3	9.0196	4,437.2	1.5150	1.2690	0.9818	1.2925
2,200	2,140.1	2,850.5	9.0720	5,327.2	1.3151	1.2734	0.9862	1.2913
2,300	2,239.0	2,978.0	9.1226	6,353.2	1.1473	1.2775	0.9902	1.2901
2,400	2,338.2	3,106.0	9.1714	7,530.1	1.0056	1.2813	0.9940	1.2889
2,500	2,437.8	3,234.3	9.2185	8,873.5	0.8853	1.2848	0.9976	1.2879
2,600	2,537.7	3,363.0	9.2641	10,401.0	0.7826	1.2882	1.0010	1.2869