

Answer the questions in the spaces provided on the question sheets.
Additional empty pages as well as Tables and charts that you may need are
provided at the end.

Note: From questions 2, 3, and 4 the best two will count, i.e., I will correct
all of these three questions and count the best two results towards your total.

SHOW ALL YOUR WORK

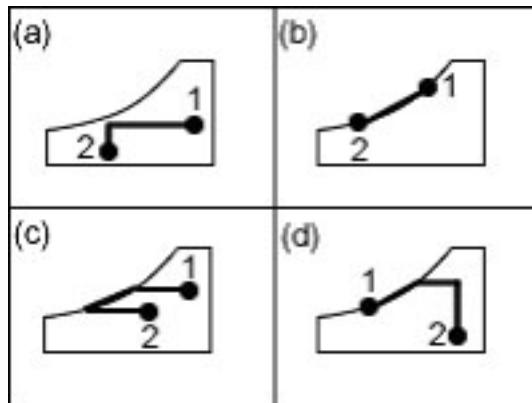
Name: _____

UT EID: _____

Question	Points	Score
Multiple Choice Questions	20	
Psychrometrics	40	
Refrigeration Cycle	40	
Heat Exchangers	40	
Total:	140	

Question 1: Multiple Choice Questions 20 points

- [2] (a) The ratio of the mass of vapor to the total mass of the moist air mixture is called
 vapor ratio
 vapor content
 index
 quality
- [4] (b) Which of the following statement is true?
 dew point temperature is the temperature at which water vapour starts condensing
 dry bulb temperature is recorded by thermometer with dry bulb
 wet bulb temperature is recorded by thermometer when bulb is covered with a cotton wick which is saturated with water
 all of the mentioned
- [2] (c) Humid air is cooled, dehumidified and reheated during an isobaric process. Which one of the psychometric charts below correctly depicts these processes?

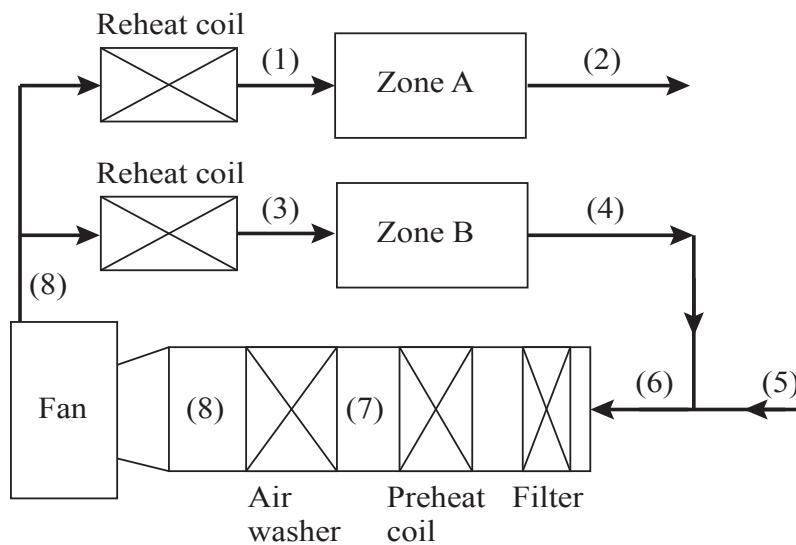


- (a)
 (b)
 (c)
 (d)

- [2] (d) At the condenser, the refrigerant changes
- from high pressure vapor to high pressure liquid
 - from high pressure vapor to low pressure liquid
 - from high pressure liquid to high pressure vapor
 - from high pressure vapor to low pressure vapor
- [2] (e) The expansion process in the theoretical single stage refrigeration cycle is
- isentropic
 - reversible
 - adiabatic
 - all of the mentioned
- [4] (f) A refrigerator has a coefficient of performance of 1.6. How much work must be supplied to this refrigerator for it to reject 1000 kJ of heat?
- 385 kJ
 - 625 kJ
 - 836 kJ
 - 1000 kJ
- [4] (g) EERC visit: What is the main reason that the air handling units and the ducts in the north tower (closer to ECJ) are larger compared to those in the south tower.
-
-
-
-

Question 2: Psychrometrics 40 points

The following Figure depicts a two-zone heating/humidifying system.



The following conditions exist:

- *Zone A* is at 60°F dry-bulb temperature and 50% relative humidity
- The mass flow rate of supply air into *Zone A* is 6000 lbm_a/hr .
- The sensible-heat loss from *Zone A* is 32'000 BTU/hr.
- *Zone B* is at 72°F dry-bulb temperature and 40% relative humidity.
- The mass flow rate of supply air into *Zone B* is 4000 lbm_a/hr .
- The sensible and latent heat losses from zone B result in an SHR = 0.7.
- Outside air is at 35°F dry-bulb temperature and 20% relative humidity.
- The preheat coil is controlled so that the air leaves the coil at a dry-bulb temperature at 80°F.
- The air exits the washer at saturated conditions.
- The system operates at standard atmospheric pressure.

Sketch and label all the points and process lines on a psychrometric chart and determine

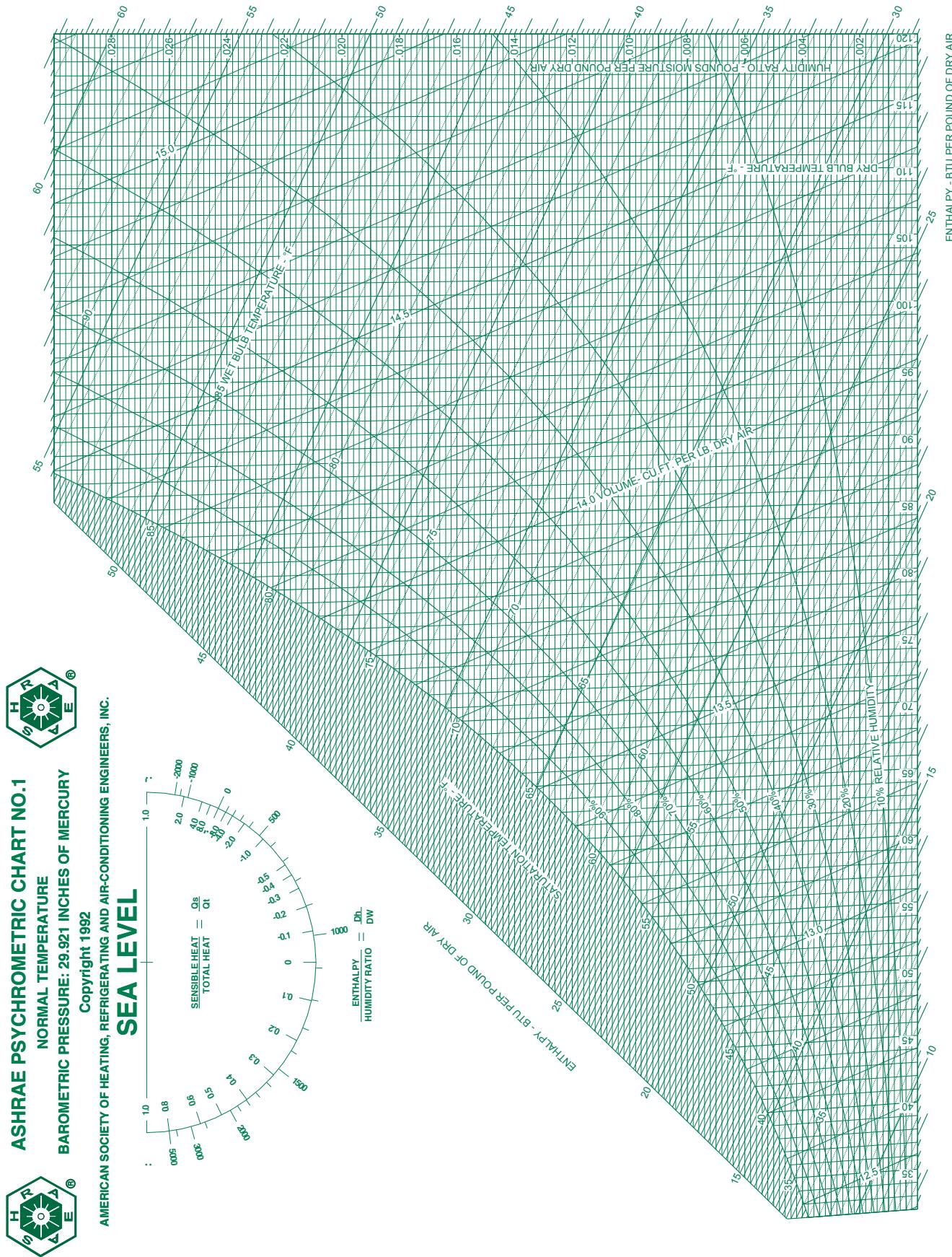
- | | |
|---|------------------------------------------------------------------------------------------|
| 6 | (a) the dry-bulb temperature and relative humidity of state 6 |
| 8 | (b) the rate of heat input by the preheat coil |
| 6 | (c) the dry-bulb and wet-bulb temperatures of state 8 |
| 7 | (d) the rate of moisture added to the air by the air washer |
| 6 | (e) the dry-bulb temperature and relative humidity of the supply for <i>zone A</i> , and |
| 7 | (f) the rate of heat input by the reheat coil for <i>zone B</i> |

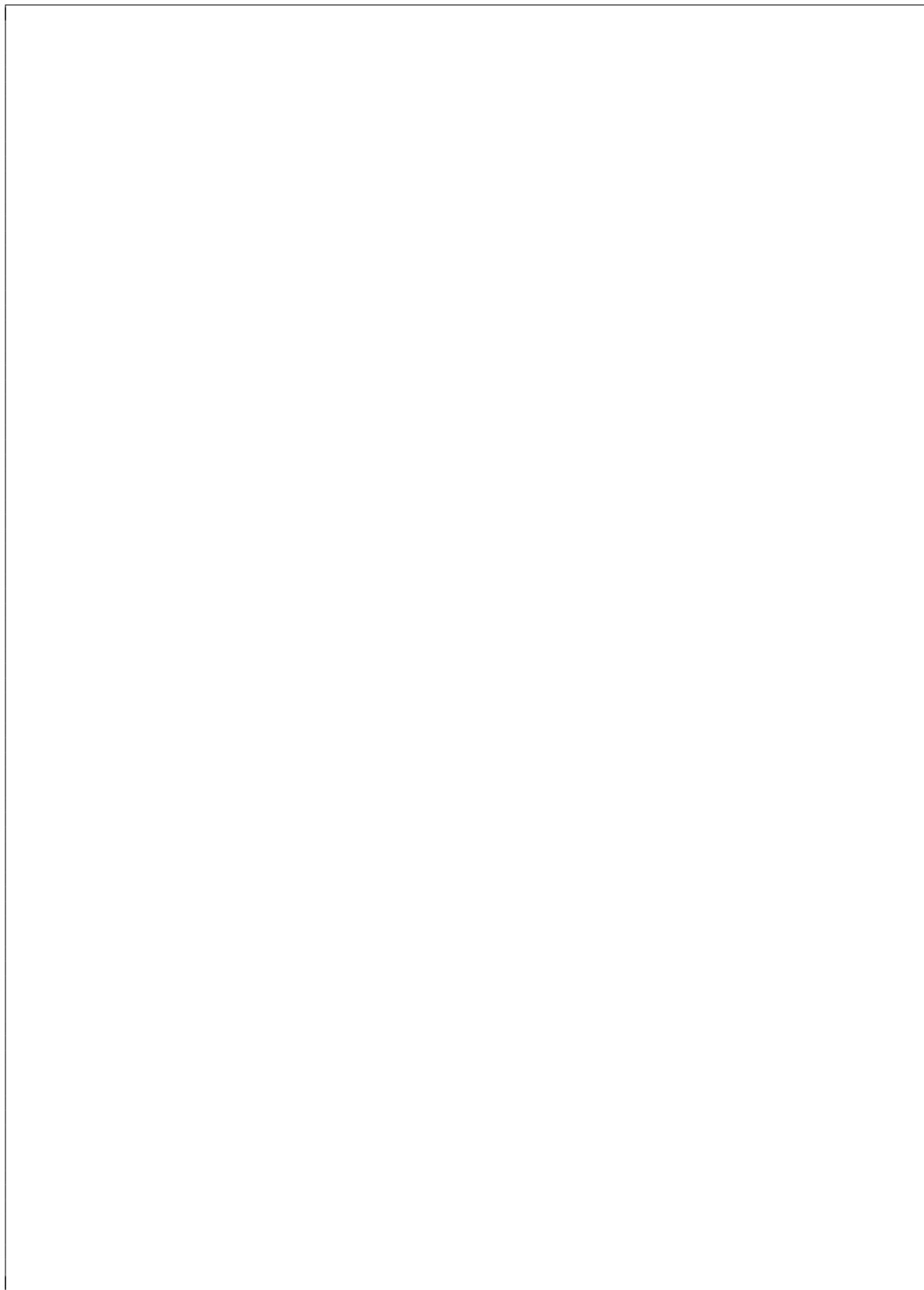
Use the following constants where necessary:

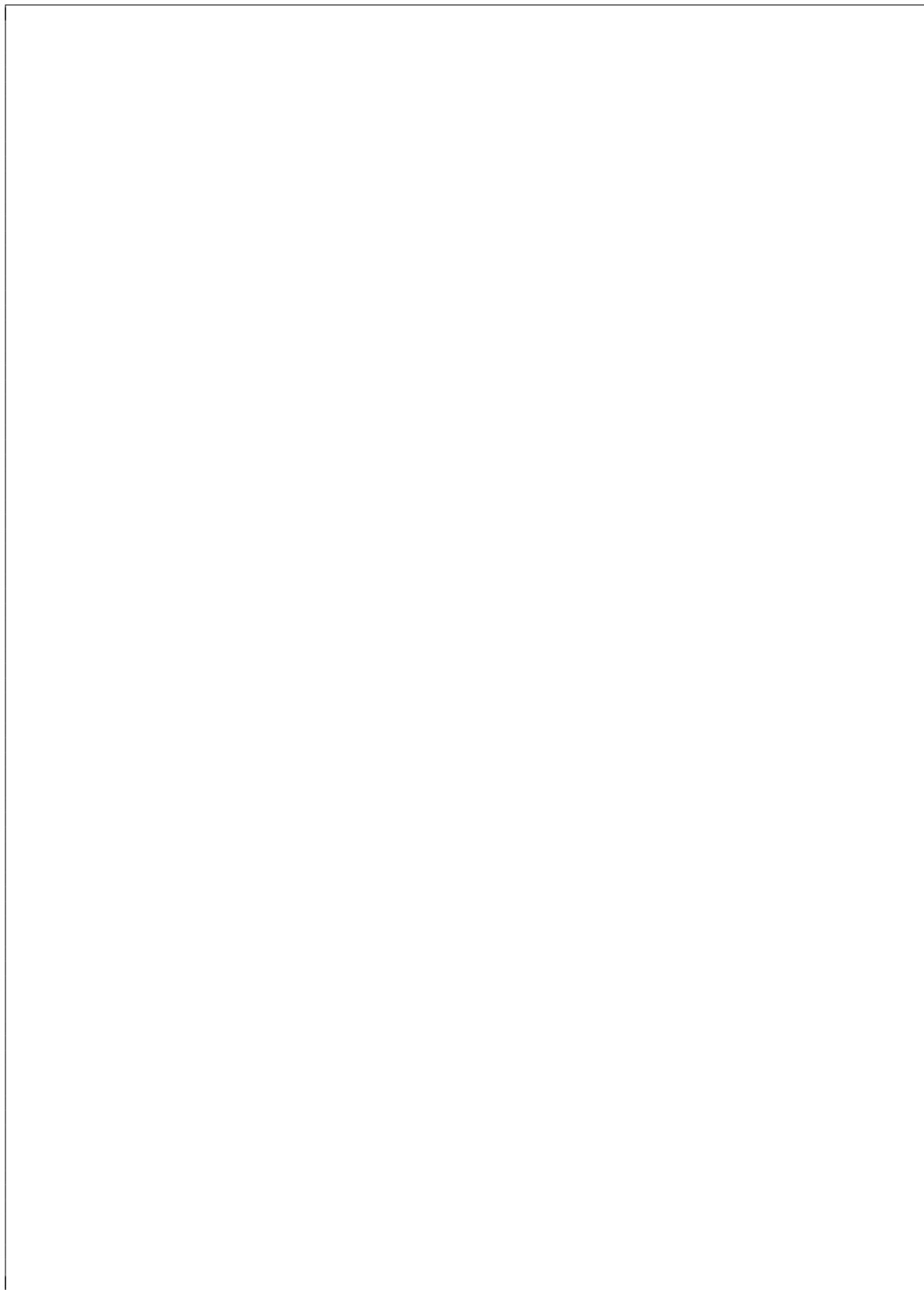
$$c_a = 0.24 \text{ Btu/lbm}_a \text{ } ^\circ\text{F}$$

$$c_{pw} = 0.444 \text{ Btu/lbm}_w \text{ } ^\circ\text{F}$$

$$\bar{c_p} = 0.245 \text{ Btu/lbm}_a \text{ } ^\circ\text{F}$$

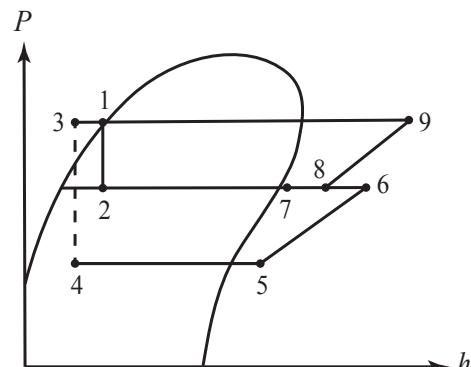
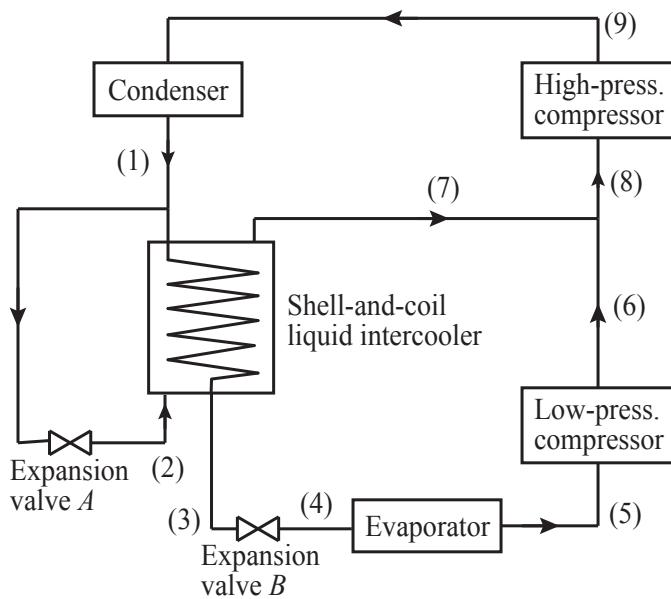






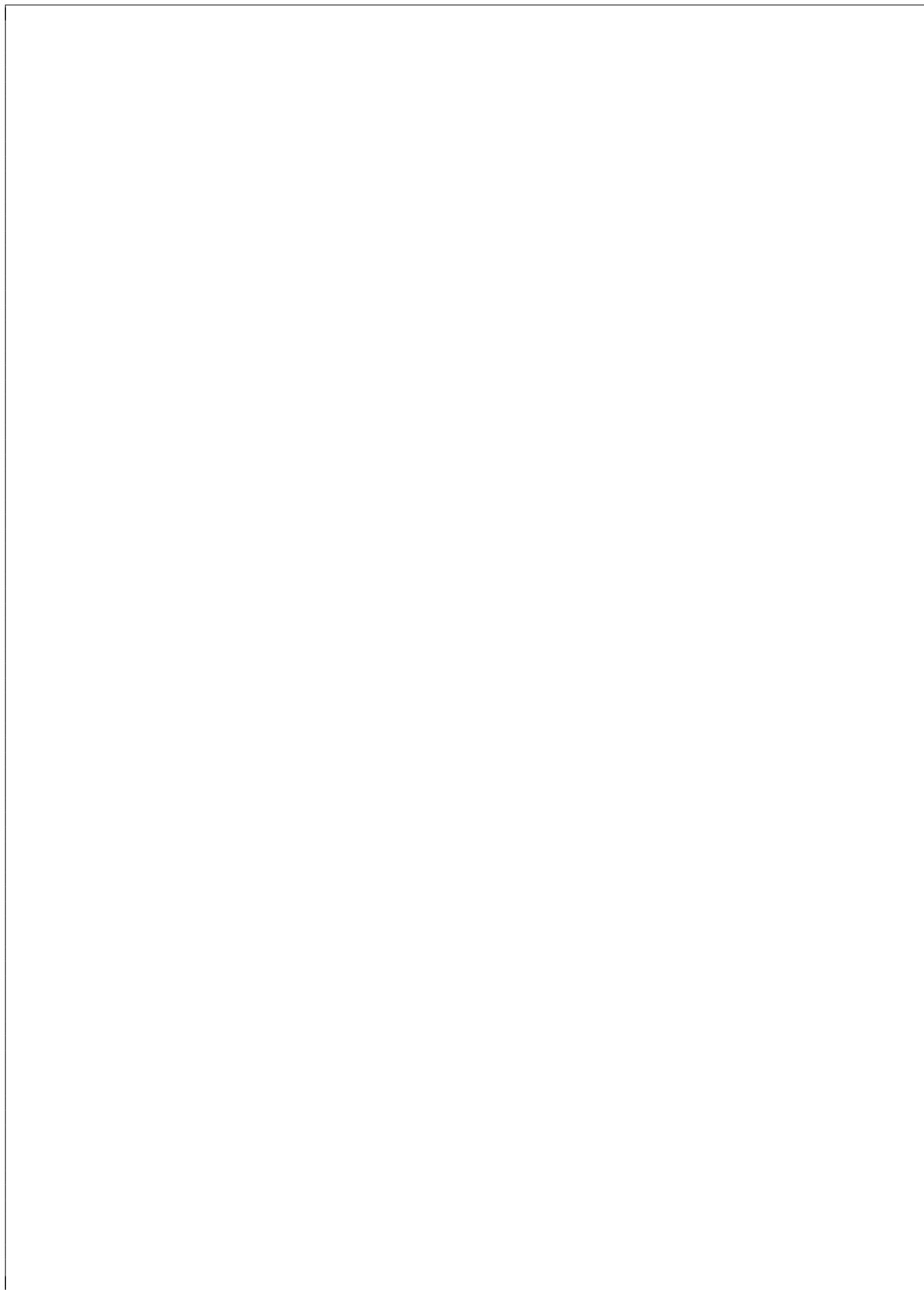
Question 3: Refrigeration Cycle 40 points

A Refrigerant-22 system is arranged as shown in the following Figure.



Condensing pressure is 1.5 MPa, intermediate pressure is 0.5 MPa, and evaporating pressure is 0.2 MPa. The following temperatures are known: $t_1 = 35^\circ\text{C}$, $t_3 = 5^\circ\text{C}$, $t_5 = -20^\circ\text{C}$, and $t_7 = 5^\circ\text{C}$. Assume isentropic compression, and frictionless flow. Calculate the coefficient of performance.

Hint: Saturation tables and P-h diagrams for R-22 are in the back



Question 4: Heat Exchangers.....40 points

Moist air at $2 \text{ m}^3/\text{s}$, 21°C dry-bulb temperature, 13°C wet-bulb temperature, a pressure of 101.325 kPa is heated to 40°C by condensing refrigerant-22 at a pressure of 1.942 MPa . The refrigerant enters as saturated vapor and leaves as saturated liquid. The refrigerant is mixed, the air is unmixed. Sketch the heat exchanger schematically (as in the HW assignments) and label (1) air entry, (2) air exit, (A) R-22 entry, and (B) R-22 exit. Use the labels as subscripts in your calculations. Determine:

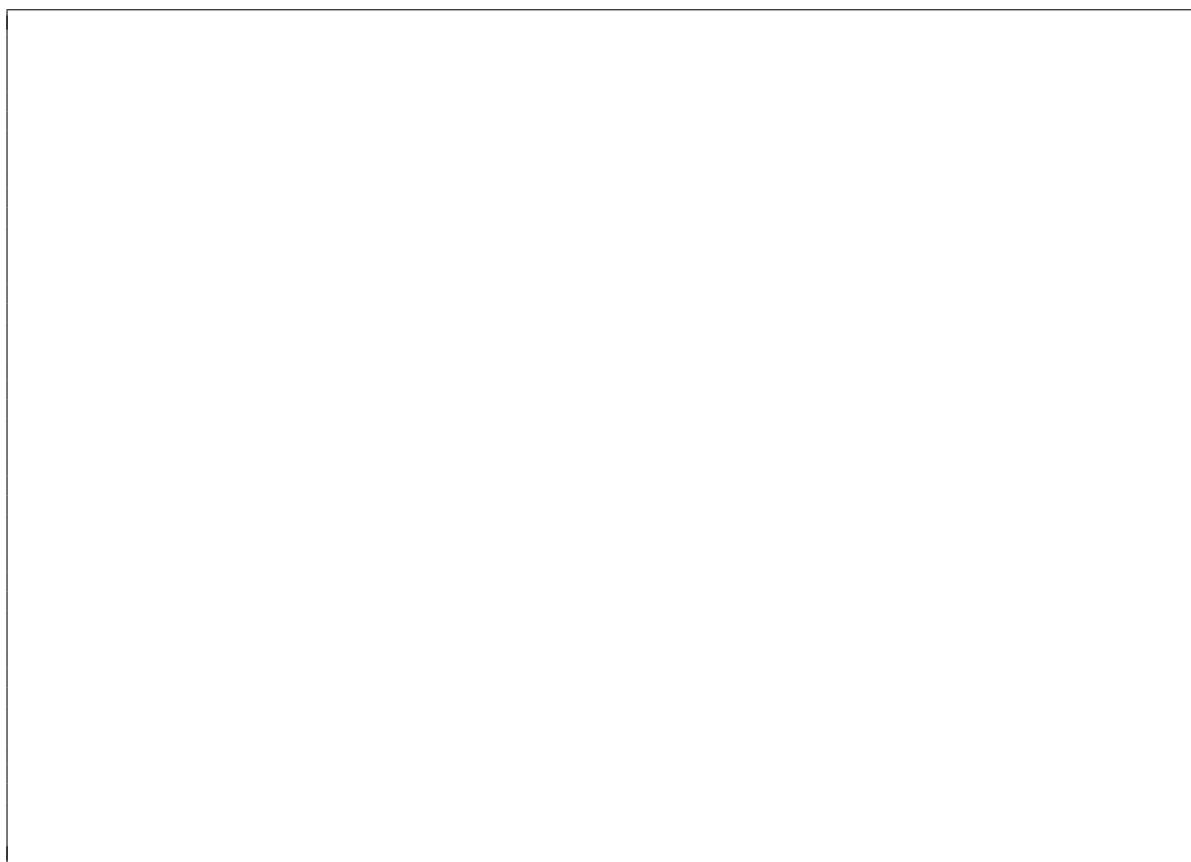
- 8 (a) the mass flow rate of refrigerant required (kg/s)
- 7 (b) the value of NTU
- 7 (c) the overall conductance of the heat exchanger (UA)
- 6 (d) the correction factor F
- 6 (e) the logarithmic mean temperature difference (LMTD), and
- 6 (f) the heating capacity of the heat exchanger (kW)

Use the psychrometric chart on the next page to determine necessary quantities.

Use the following constants where necessary:

$$c_a = 1.0 \text{ kJ/kg}_a^\circ\text{C}$$

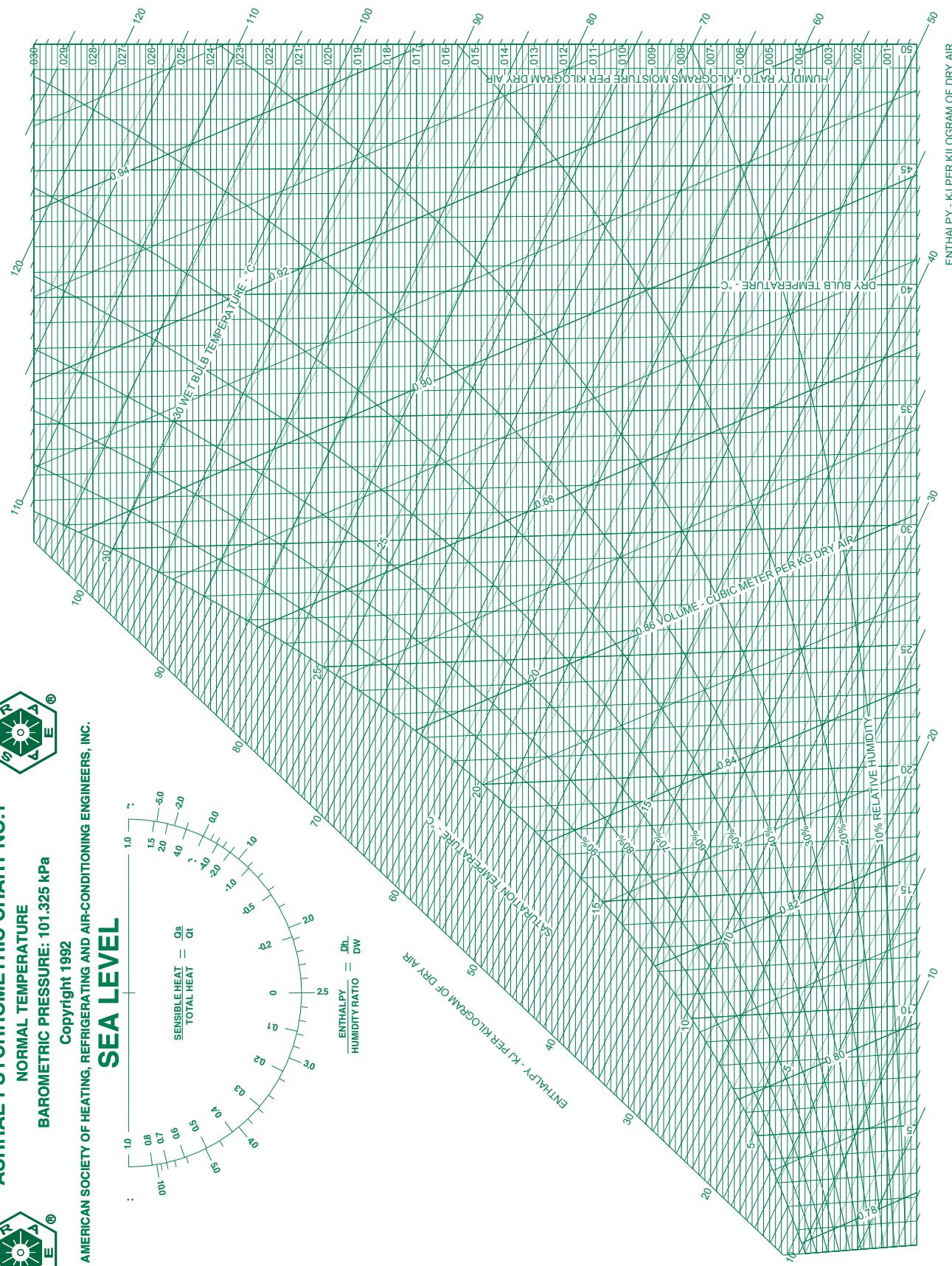
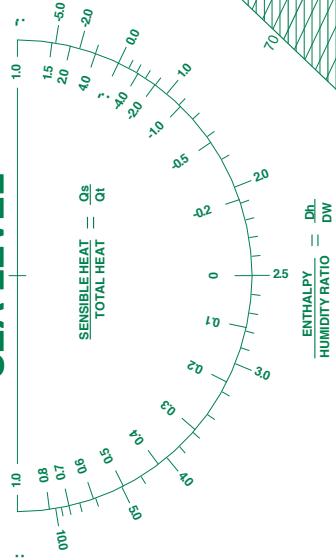
$$c_{pw} = 1.86 \text{ kJ/kg}_w^\circ\text{C}$$

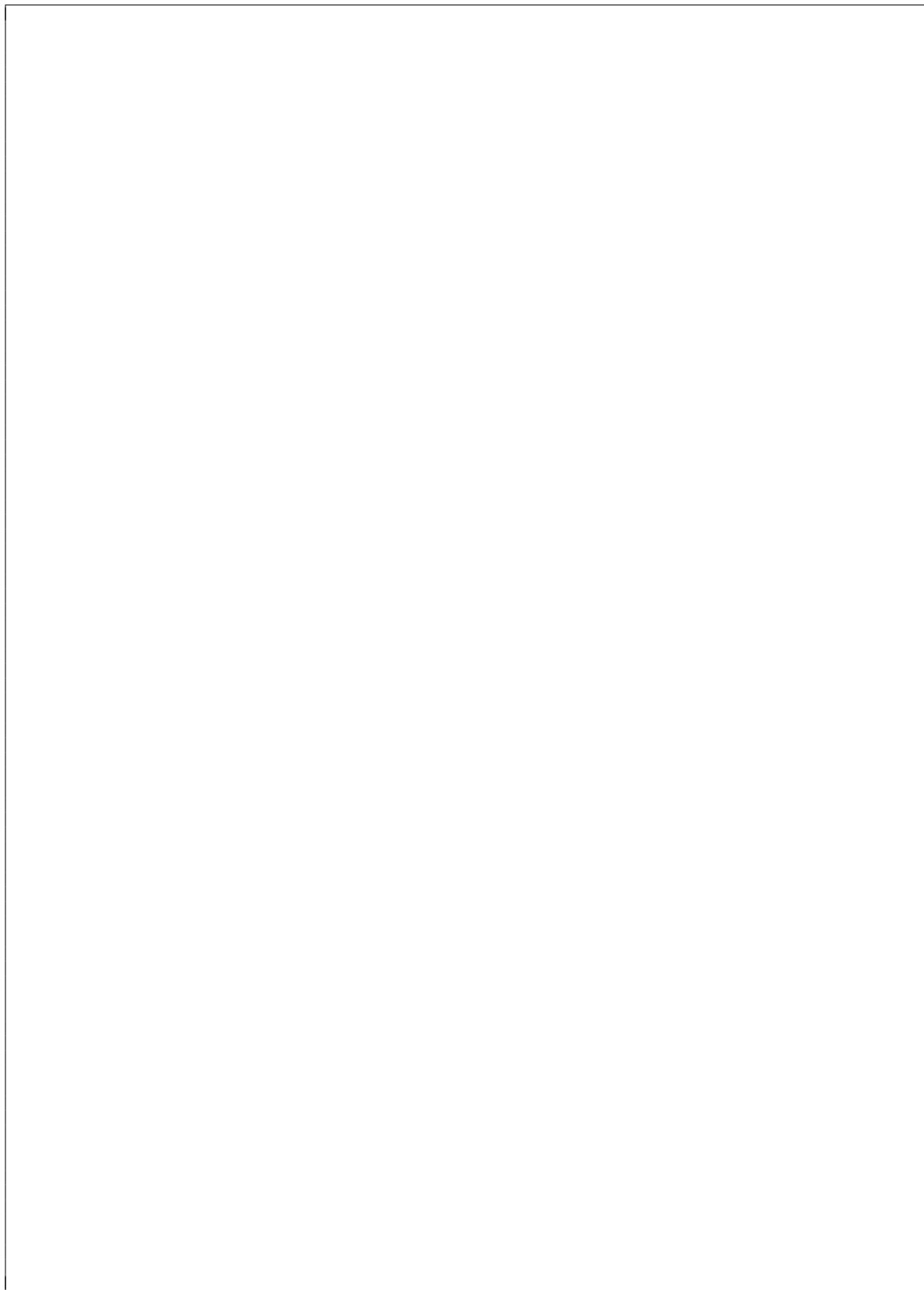


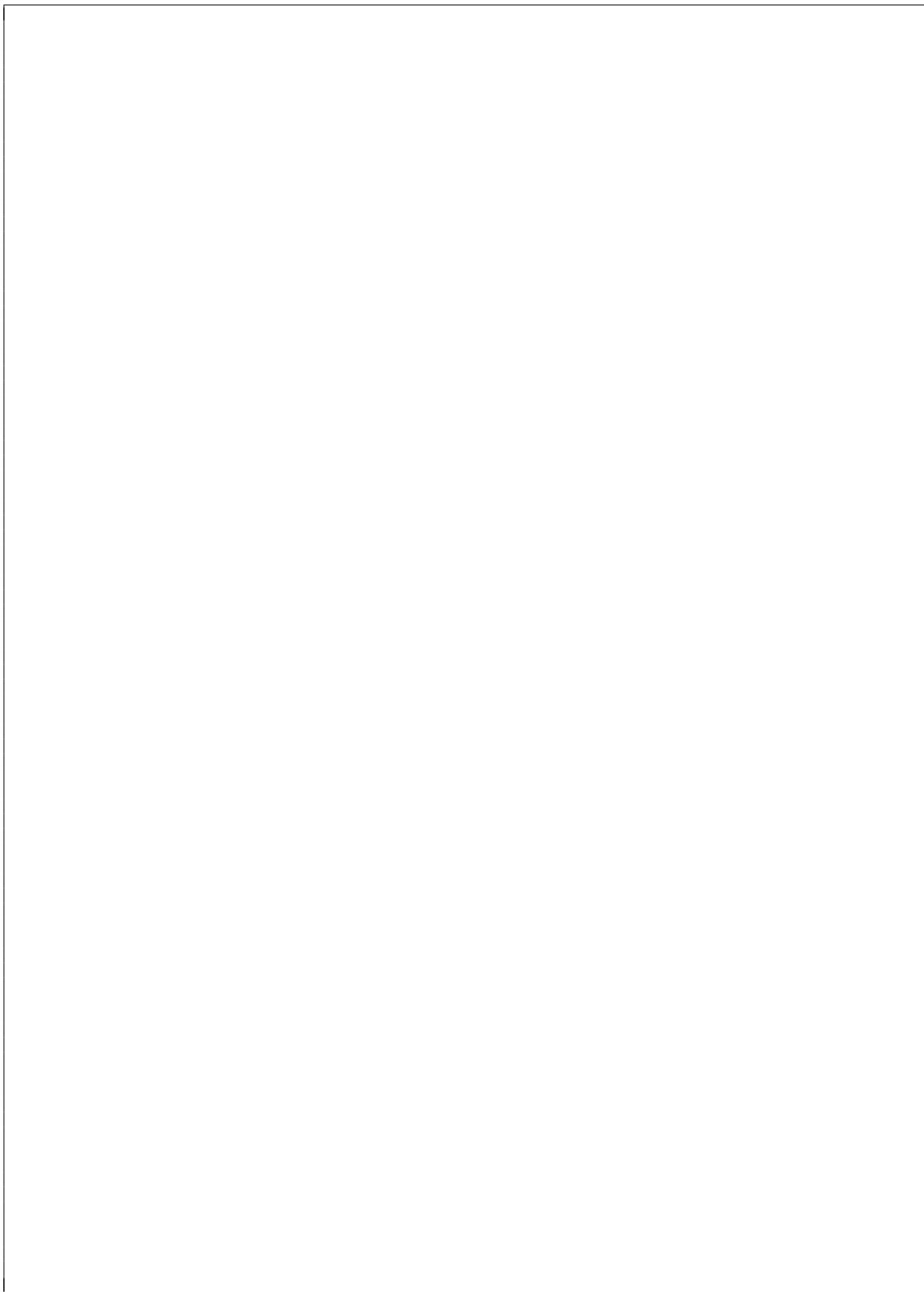
**ASHRAE PSYCHROMETRIC CHART NO.1**

NORMAL TEMPERATURE

BAROMETRIC PRESSURE: 101.325 kPa

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THERMODYNAMIC PROPERTIES OF R22 AT SATURATION (ENGLISH UNITS)

Temp. °F	Pressure		Liquid, Density lbm/ft ³ \bar{L}/\bar{v}_f	Vapor, Sp. Vol. ft ³ /lbm v_g	Enthalpy, Datum -40 °F, Btu/lbm		Entropy, Datum -40 °F, Btu/lbm · °R	
	psia	psig			Liquid \bar{h}_f	Vapor \bar{h}_g	Liquid s_f	Vapor s_g
-100.	2.40	*25.1	93.77	18.444	-14.6	93.4	-0.0373	0.2627
-95.	2.87	*24.1	93.31	15.588	-13.4	94.0	-0.0341	0.2602
-90.	3.42	*23.0	92.85	13.243	-12.2	94.5	-0.0309	0.2578
-85.	4.05	*21.7	92.38	11.307	-11.0	95.1	-0.0277	0.2556
-80.	4.78	*20.2	91.91	9.700	-9.8	95.7	-0.0246	0.2534
-75.	5.61	*18.6	91.43	8.360	-8.6	96.3	-0.0214	0.2513
-70.	6.55	*16.6	90.95	7.236	-7.4	96.9	-0.0183	0.2493
-65.	7.61	*14.5	90.47	6.289	-6.2	97.4	-0.0152	0.2474
-60.	8.81	*12.0	89.99	5.487	-5.0	98.0	-0.0121	0.2455
-58.	9.33	*10.9	89.79	5.201	-4.5	98.2	-0.0109	0.2448
-56.	9.88	*9.8	89.60	4.934	-4.0	98.5	-0.0097	0.2441
-54.	10.45	*8.7	89.40	4.682	-3.5	98.7	-0.0085	0.2434
-52.	11.04	*7.5	89.20	4.446	-3.0	98.9	-0.0073	0.2427
-50.	11.67	*6.2	89.01	4.224	-2.5	99.1	-0.0060	0.2421
-48.	12.32	*4.9	88.81	4.016	-2.0	99.4	-0.0048	0.2414
-46.	13.00	*3.5	88.61	3.820	-1.5	99.6	-0.0036	0.2407
-44.	13.71	*2.0	88.41	3.635	-1.0	99.8	-0.0024	0.2401
-42.	14.44	*0.5	88.21	3.461	-0.5	100.0	-0.0012	0.2395
-40.	15.21	0.5	88.01	3.297	0.0	100.3	0.0000	0.2388
-38.	16.02	1.3	87.81	3.143	0.5	100.5	0.0012	0.2382
-36.	16.85	2.2	87.60	2.997	1.0	100.7	0.0024	0.2376
-34.	17.72	3.0	87.40	2.859	1.5	100.9	0.0036	0.2370
-32.	18.62	3.9	87.20	2.729	2.0	101.1	0.0048	0.2365
-30.	19.56	4.9	86.99	2.606	2.5	101.3	0.0060	0.2359
-29.	20.05	5.4	86.89	2.547	2.8	101.5	0.0066	0.2356
-28.	20.54	5.8	86.79	2.490	3.1	101.6	0.0072	0.2353
-27.	21.04	6.3	86.68	2.434	3.3	101.7	0.0078	0.2350
-26.	21.55	6.9	86.58	2.380	3.6	101.8	0.0083	0.2348
-25.	22.08	7.4	86.48	2.327	3.8	101.9	0.0089	0.2345
-24.	22.61	7.9	86.37	2.276	4.1	102.0	0.0095	0.2342
-23.	23.15	8.5	86.27	2.226	4.4	102.1	0.0101	0.2339
-22.	23.70	9.0	86.17	2.177	4.6	102.2	0.0107	0.2337
-21.	24.26	9.6	86.06	2.130	4.9	102.3	0.0113	0.2334
-20.	24.83	10.1	85.96	2.083	5.1	102.4	0.0119	0.2331
-19.	25.42	10.7	85.85	2.038	5.4	102.5	0.0125	0.2329
-18.	26.01	11.3	85.75	1.995	5.7	102.6	0.0131	0.2326
-17.	26.61	11.9	85.64	1.952	5.9	102.7	0.0137	0.2323
-16.	27.23	12.5	85.54	1.911	6.2	102.8	0.0142	0.2321
-15.	27.85	13.2	85.43	1.870	6.4	102.9	0.0148	0.2318
-14.	28.49	13.8	85.33	1.831	6.7	103.0	0.0154	0.2316
-13.	29.14	14.4	85.22	1.792	7.0	103.1	0.0160	0.2313
-12.	29.80	15.1	85.12	1.755	7.2	103.3	0.0166	0.2310
-11.	30.47	15.8	85.01	1.719	7.5	103.4	0.0172	0.2308
-10.	31.15	16.5	84.90	1.683	7.8	103.5	0.0178	0.2305
-9.	31.84	17.1	84.80	1.648	8.0	103.6	0.0183	0.2303
-8.	32.55	17.9	84.69	1.615	8.3	103.7	0.0189	0.2301
-7.	33.27	18.6	84.58	1.582	8.5	103.8	0.0195	0.2298
-6.	34.00	19.3	84.48	1.550	8.8	103.9	0.0201	0.2296
-5.	34.74	20.0	84.37	1.518	9.1	104.0	0.0207	0.2293
-4.	35.49	20.8	84.26	1.488	9.3	104.1	0.0212	0.2291
-3.	36.26	21.6	84.15	1.458	9.6	104.2	0.0218	0.2288
-2.	37.04	22.3	84.04	1.429	9.9	104.3	0.0224	0.2286
-1.	37.84	23.1	83.94	1.400	10.1	104.4	0.0230	0.2284
0.	38.64	23.9	83.83	1.373	10.4	104.5	0.0236	0.2281
1.	39.46	24.8	83.72	1.346	10.7	104.6	0.0241	0.2279
2.	40.29	25.6	83.61	1.319	10.9	104.7	0.0247	0.2277
3.	41.14	26.4	83.50	1.294	11.2	104.8	0.0253	0.2274
4.	42.00	27.3	83.39	1.268	11.5	104.9	0.0259	0.2272
5.	42.87	28.2	83.28	1.244	11.8	105.0	0.0265	0.2270
6.	43.76	29.1	83.17	1.220	12.0	105.1	0.0270	0.2268
7.	44.66	30.0	83.06	1.196	12.3	105.2	0.0276	0.2265
8.	45.57	30.9	82.95	1.174	12.6	105.2	0.0282	0.2263
9.	46.50	31.8	82.84	1.151	12.8	105.3	0.0288	0.2261
10.	47.45	32.8	82.73	1.129	13.1	105.4	0.0293	0.2259

* Inches of mercury below one standard atmosphere (29.92 in).

THERMODYAMIC PROPERTIES OF R22 AT SATURATION (ENGLISH UNITS) p.2

Temp. °F	Pressure		Liquid, Density lbm/ft ³ l/v _f	Vapor, Sp. Vol. ft ³ /lbm v _g	Enthalpy, Datum -40 °F, Btu/lbm		Entropy, Datum -40 °F, Btu/lbm · °R	
	psia	psig			Liquid h _f	Vapor h _g	Liquid s _f	Vapor s _g
11.	48.40	33.7	82.62	1.108	13.4	105.5	0.0299	0.2257
12.	49.38	34.7	82.50	1.087	13.7	105.6	0.0305	0.2254
13.	50.37	35.7	82.39	1.067	13.9	105.7	0.0310	0.2252
14.	51.37	36.7	82.28	1.047	14.2	105.8	0.0316	0.2250
15.	52.39	37.7	82.17	1.027	14.5	105.9	0.0322	0.2248
16.	53.42	38.7	82.05	1.008	14.7	106.0	0.0328	0.2246
17.	54.47	39.8	81.94	0.990	15.0	106.1	0.0333	0.2244
18.	55.53	40.8	81.83	0.972	15.3	106.2	0.0339	0.2242
19.	56.61	41.9	81.71	0.954	15.6	106.3	0.0345	0.2240
20.	57.71	43.0	81.60	0.937	15.8	106.4	0.0350	0.2238
21.	58.82	44.1	81.49	0.920	16.1	106.5	0.0356	0.2236
22.	59.95	45.3	81.37	0.903	16.4	106.6	0.0362	0.2233
23.	61.09	46.4	81.26	0.887	16.7	106.7	0.0367	0.2231
24.	62.25	47.6	81.14	0.871	16.9	106.7	0.0373	0.2229
25.	63.43	48.7	81.03	0.855	17.2	106.8	0.0379	0.2227
26.	64.62	49.9	80.91	0.840	17.5	106.9	0.0384	0.2225
27.	65.83	51.1	80.79	0.825	17.8	107.0	0.0390	0.2223
28.	67.06	52.4	80.68	0.810	18.1	107.1	0.0396	0.2221
29.	68.31	53.6	80.56	0.796	18.3	107.2	0.0401	0.2219
30.	69.57	54.9	80.44	0.782	18.6	107.3	0.0407	0.2217
31.	70.85	56.2	80.33	0.769	18.9	107.4	0.0413	0.2216
32.	72.14	57.4	80.21	0.755	19.2	107.5	0.0418	0.2214
33.	73.46	58.8	80.09	0.742	19.4	107.5	0.0424	0.2212
34.	74.79	60.1	79.97	0.729	19.7	107.6	0.0429	0.2210
35.	76.14	61.4	79.86	0.717	20.0	107.7	0.0435	0.2208
36.	77.51	62.8	79.74	0.704	20.3	107.8	0.0441	0.2206
37.	78.90	64.2	79.62	0.692	20.6	107.9	0.0446	0.2204
38.	80.31	65.6	79.50	0.681	20.9	108.0	0.0452	0.2202
39.	81.73	67.0	79.38	0.669	21.1	108.1	0.0457	0.2200
40.	83.18	68.5	79.26	0.658	21.4	108.1	0.0463	0.2198
41.	84.64	69.9	79.14	0.647	21.7	108.2	0.0469	0.2196
42.	86.13	71.4	79.02	0.636	22.0	108.3	0.0474	0.2195
43.	87.63	72.9	78.90	0.625	22.3	108.4	0.0480	0.2193
44.	89.15	74.5	78.77	0.615	22.6	108.5	0.0485	0.2191
45.	90.69	76.0	78.65	0.604	22.8	108.6	0.0491	0.2189
46.	92.25	77.6	78.53	0.594	23.1	108.6	0.0497	0.2187
47.	93.83	79.1	78.41	0.585	23.4	108.7	0.0502	0.2185
48.	95.43	80.7	78.28	0.575	23.7	108.8	0.0508	0.2184
49.	97.05	82.4	78.16	0.565	24.0	108.9	0.0513	0.2182
50.	98.70	84.0	78.04	0.556	24.3	109.0	0.0519	0.2180
51.	100.36	85.7	77.91	0.547	24.6	109.0	0.0524	0.2178
52.	102.04	87.3	77.79	0.538	24.9	109.1	0.0530	0.2176
53.	103.75	89.1	77.66	0.529	25.1	109.2	0.0536	0.2175
54.	105.47	90.8	77.54	0.521	25.4	109.3	0.0541	0.2173
55.	107.22	92.5	77.41	0.513	25.7	109.3	0.0547	0.2171
56.	108.99	94.3	77.28	0.504	26.0	109.4	0.0552	0.2169
57.	110.78	96.1	77.16	0.496	26.3	109.5	0.0558	0.2168
58.	112.59	97.9	77.03	0.488	26.6	109.6	0.0563	0.2166
59.	114.42	99.7	76.90	0.480	26.9	109.6	0.0569	0.2164
60.	116.28	101.6	76.78	0.473	27.2	109.7	0.0574	0.2162
61.	118.16	103.5	76.65	0.465	27.5	109.8	0.0580	0.2161
62.	120.06	105.4	76.52	0.458	27.8	109.9	0.0585	0.2159
63.	121.98	107.3	76.39	0.451	28.0	109.9	0.0591	0.2157
64.	123.92	109.2	76.26	0.444	28.3	110.0	0.0596	0.2155
65.	125.89	111.2	76.13	0.437	28.6	110.1	0.0602	0.2154
66.	127.88	113.2	76.00	0.430	28.9	110.1	0.0607	0.2152
67.	129.90	115.2	75.87	0.423	29.2	110.2	0.0613	0.2150
68.	131.94	117.2	75.74	0.417	29.5	110.3	0.0619	0.2149
69.	134.00	119.3	75.60	0.410	29.8	110.3	0.0624	0.2147
70.	136.08	121.4	75.47	0.404	30.1	110.4	0.0630	0.2145

THERMODYNAMIC PROPERTIES OF R22 AT SATURATION (ENGLISH UNITS) p. 3

Temp. °F	Pressure		Liquid, Density lbm/ft ³ 1/V _f	Vapor, Sp. Vol. ft ³ /lbm v _g	Enthalpy, Datum -40 °F, Btu/lbm		Entropy, Datum -40 °F, Btu/lbm · °R	
	psia	psig			Liquid h _f	Vapor h _g	Liquid s _f	Vapor s _g
71.	138.19	123.5	75.34	0.398	30.4	110.5	0.0635	0.2144
72.	140.33	125.6	75.21	0.391	30.7	110.5	0.0641	0.2142
73.	142.48	127.8	75.07	0.385	31.0	110.6	0.0646	0.2140
74.	144.67	130.0	74.94	0.380	31.3	110.7	0.0652	0.2139
75.	146.87	132.2	74.80	0.374	31.6	110.7	0.0657	0.2137
76.	149.11	134.4	74.67	0.368	31.9	110.8	0.0663	0.2135
77.	151.36	136.7	74.53	0.363	32.2	110.9	0.0668	0.2134
78.	153.64	138.9	74.39	0.357	32.5	110.9	0.0674	0.2132
79.	155.95	141.3	74.26	0.352	32.8	111.0	0.0679	0.2130
80.	158.28	143.6	74.12	0.346	33.1	111.1	0.0684	0.2129
81.	160.64	145.9	73.98	0.341	33.4	111.1	0.0690	0.2127
82.	163.02	148.3	73.84	0.336	33.7	111.2	0.0695	0.2125
83.	165.43	150.7	73.70	0.331	34.0	111.2	0.0701	0.2124
84.	167.87	153.2	73.56	0.326	34.3	111.3	0.0707	0.2122
85.	170.33	155.6	73.42	0.321	34.6	111.3	0.0712	0.2120
86.	172.82	158.1	73.28	0.316	34.9	111.4	0.0717	0.2119
87.	175.34	160.6	73.14	0.312	35.2	111.5	0.0723	0.2117
88.	177.88	163.2	73.00	0.307	35.5	111.5	0.0728	0.2115
89.	180.45	165.8	72.86	0.302	35.8	111.6	0.0734	0.2114
90.	183.05	168.4	72.71	0.298	36.2	111.6	0.0739	0.2112
91.	185.67	171.0	72.57	0.294	36.5	111.7	0.0745	0.2110
92.	188.32	173.6	72.42	0.289	36.8	111.7	0.0750	0.2109
93.	191.00	176.3	72.28	0.285	37.1	111.8	0.0756	0.2107
94.	193.71	179.0	72.13	0.281	37.4	111.8	0.0761	0.2105
95.	196.44	181.7	71.98	0.277	37.7	111.9	0.0767	0.2104
96.	199.21	184.5	71.84	0.273	38.0	111.9	0.0772	0.2102
97.	202.00	187.3	71.69	0.269	38.3	112.0	0.0778	0.2100
98.	204.82	190.1	71.54	0.265	38.6	112.0	0.0783	0.2099
99.	207.67	193.0	71.39	0.261	39.0	112.1	0.0789	0.2097
100.	210.55	195.9	71.24	0.257	39.3	112.1	0.0794	0.2095
101.	213.46	198.8	71.09	0.253	39.6	112.2	0.0800	0.2094
102.	216.40	201.7	70.94	0.250	39.9	112.2	0.0805	0.2092
103.	219.36	204.7	70.78	0.246	40.2	112.2	0.0811	0.2090
104.	222.36	207.7	70.63	0.243	40.5	112.3	0.0816	0.2089
105.	225.39	210.7	70.48	0.239	40.8	112.3	0.0821	0.2087
106.	228.45	213.8	70.32	0.236	41.2	112.4	0.0827	0.2085
107.	231.53	216.8	70.17	0.232	41.5	112.4	0.0832	0.2084
108.	234.65	220.0	70.01	0.229	41.8	112.4	0.0838	0.2082
109.	237.80	223.1	69.85	0.226	42.1	112.5	0.0843	0.2080
110.	240.98	226.3	69.69	0.222	42.4	112.5	0.0849	0.2078
111.	244.20	229.5	69.53	0.219	42.8	112.5	0.0854	0.2077
112.	247.44	232.7	69.37	0.216	43.1	112.6	0.0860	0.2075
113.	250.71	236.0	69.21	0.213	43.4	112.6	0.0865	0.2073
114.	254.02	239.3	69.05	0.210	43.7	112.6	0.0871	0.2072
115.	257.36	242.7	68.89	0.207	44.1	112.7	0.0876	0.2070
116.	260.73	246.0	68.72	0.204	44.4	112.7	0.0882	0.2068
117.	264.13	249.4	68.56	0.201	44.7	112.7	0.0887	0.2066
118.	267.57	252.9	68.39	0.198	45.0	112.7	0.0893	0.2065
119.	271.04	256.3	68.23	0.195	45.4	112.8	0.0899	0.2063
120.	274.54	259.8	68.06	0.192	45.7	112.8	0.0904	0.2061
122.	281.64	266.9	67.72	0.187	46.4	112.8	0.0915	0.2057
124.	288.88	274.2	67.38	0.182	47.0	112.9	0.0926	0.2054
126.	296.26	281.6	67.03	0.177	47.7	112.9	0.0937	0.2050
128.	303.77	289.1	66.67	0.172	48.4	112.9	0.0949	0.2047
130.	311.42	296.7	66.32	0.167	49.1	112.9	0.0960	0.2043
132.	319.22	304.5	65.95	0.162	49.7	113.0	0.0971	0.2039
134.	327.16	312.5	65.59	0.157	50.4	113.0	0.0982	0.2035
136.	335.25	320.6	65.21	0.153	51.1	113.0	0.0993	0.2031
138.	343.48	328.8	64.83	0.148	51.8	112.9	0.1005	0.2027
140.	351.87	337.2	64.45	0.144	52.5	112.9	0.1016	0.2023

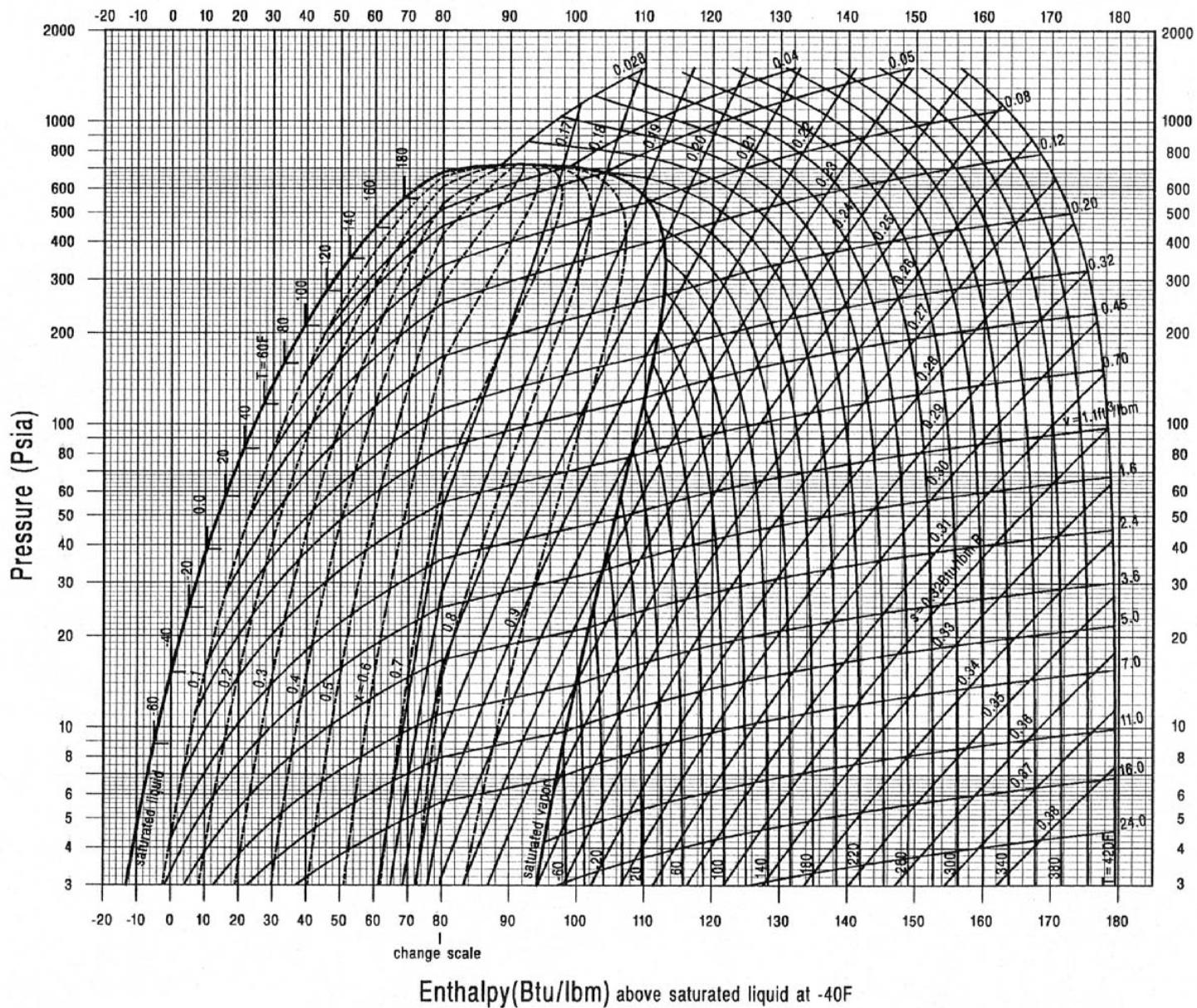
THERMODYNAMIC PROPERTIES OF R22 AT SATURATION (SI UNITS)

Temp. °C	Pressure MPa	Liquid Density kg/m ³ l/v _f	Vapor Sp. Vol. m ³ /kg v _g	Enthalpy, Datum -40 °C, kJ/kg		Entropy, Datum -40 °C, kJ/kg · K	
				Sat. Liquid h _f	Sat. Vapor h _g	Sat. Liquid s _f	Sat. Vapor s _g
-70	0.0205	1493.2	0.94151	-30.61	218.82	-0.1401	1.0877
-68	0.0233	1487.8	0.83743	-28.63	219.80	-0.1305	1.0805
-66	0.0263	1482.5	0.74678	-26.65	220.78	-0.1209	1.0736
-64	0.0297	1477.5	0.66763	-24.66	221.76	-0.1113	1.0669
-62	0.0334	1471.6	0.59831	-22.66	222.73	-0.1018	1.0603
-60	0.0375	1466.1	0.53745	-20.65	223.70	-0.0924	1.0540
-58	0.0419	1460.6	0.48387	-18.63	224.67	-0.0829	1.0479
-56	0.0468	1455.1	0.43659	-16.60	225.64	-0.0736	1.0420
-54	0.0522	1449.6	0.39476	-14.56	226.60	-0.0642	1.0362
-52	0.0580	1444.0	0.35768	-12.51	227.56	-0.0550	1.0306
-50	0.0644	1438.4	0.32472	-10.46	228.51	-0.0457	1.0252
-49	0.0677	1435.5	0.30962	-9.42	228.98	-0.0411	1.0225
-48	0.0712	1432.7	0.29536	-8.39	229.46	-0.0365	1.0199
-47	0.0749	1429.9	0.28189	-7.35	229.93	-0.0319	1.0173
-46	0.0787	1427.0	0.26915	-6.30	230.40	-0.0273	1.0148
-45	0.0827	1424.2	0.25711	-5.26	230.87	-0.0227	1.0122
-44	0.0868	1421.3	0.24571	-4.21	231.34	-0.0182	1.0098
-43	0.0911	1418.4	0.23492	-3.16	231.81	-0.0136	1.0073
-42	0.0955	1415.6	0.22470	-2.11	232.27	-0.0091	1.0049
-41	0.1001	1412.7	0.21502	-1.06	232.74	-0.0045	1.0025
-40	0.1049	1409.8	0.20584	0.00	233.20	0.0000	1.0002
-39	0.1099	1406.9	0.19713	1.06	233.66	0.0045	0.9979
-38	0.1150	1403.9	0.18886	2.12	234.12	0.0090	0.9956
-37	0.1204	1401.0	0.18101	3.19	234.58	0.0135	0.9934
-36	0.1259	1398.1	0.17355	4.26	235.03	0.0180	0.9912
-35	0.1316	1395.1	0.16647	5.33	235.49	0.0225	0.9890
-34	0.1375	1392.2	0.15973	6.40	235.94	0.0270	0.9868
-33	0.1437	1389.2	0.15333	7.48	236.39	0.0315	0.9847
-32	0.1500	1386.2	0.14723	8.56	236.84	0.0360	0.9826
-31	0.1566	1383.3	0.14143	9.64	237.28	0.0404	0.9805
-30	0.1634	1380.3	0.13590	10.73	237.73	0.0449	0.9785
-29	0.1704	1377.3	0.13063	11.81	238.17	0.0493	0.9764
-28	0.1777	1374.2	0.12561	12.90	238.61	0.0537	0.9744
-27	0.1852	1371.2	0.12082	14.00	239.05	0.0582	0.9725
-26	0.1929	1368.2	0.11626	15.09	239.49	0.0626	0.9705
-25	0.2009	1365.1	0.11190	16.19	239.92	0.0670	0.9686
-24	0.2091	1362.1	0.10774	17.30	240.35	0.0714	0.9667
-23	0.2176	1359.0	0.10377	18.40	240.78	0.0758	0.9648
-22	0.2264	1355.9	0.09997	19.51	241.21	0.0802	0.9630
-21	0.2354	1352.8	0.09634	20.62	241.63	0.0846	0.9611
-20	0.2447	1349.7	0.09288	21.73	242.06	0.0890	0.9593
-19	0.2543	1346.6	0.08956	22.85	242.48	0.0933	0.9575
-18	0.2642	1343.5	0.08638	23.97	242.89	0.0977	0.9558
-17	0.2744	1340.3	0.08335	25.09	243.31	0.1021	0.9540
-16	0.2848	1337.2	0.08044	26.21	243.72	0.1064	0.9523
-15	0.2956	1334.0	0.07765	27.34	244.13	0.1108	0.9506
-14	0.3067	1330.8	0.07498	28.47	244.54	0.1151	0.9489
-13	0.3181	1327.6	0.07242	29.60	244.95	0.1194	0.9472
-12	0.3298	1324.4	0.06997	30.74	245.35	0.1238	0.9455
-11	0.3418	1321.2	0.06762	31.88	245.75	0.1281	0.9439
-10	0.3542	1318.0	0.06536	33.02	246.15	0.1324	0.9423
-9	0.3669	1314.7	0.06319	34.17	246.54	0.1367	0.9407
-8	0.3799	1311.5	0.06111	35.32	246.93	0.1410	0.9391
-7	0.3933	1308.2	0.05912	36.47	247.32	0.1453	0.9375
-6	0.4071	1304.9	0.05720	37.62	247.70	0.1496	0.9360
-5	0.4212	1301.6	0.05535	38.78	248.09	0.1539	0.9344
-4	0.4357	1298.3	0.05358	39.94	248.47	0.1581	0.9329
-3	0.4505	1294.9	0.05188	41.10	248.84	0.1624	0.9314
-2	0.4658	1291.6	0.05024	42.27	249.21	0.1667	0.9299
-1	0.4814	1288.2	0.04867	43.41	249.58	0.1709	0.9284

THERMODYNAMIC PROPERTIES OF R22 AT SATURATION p.2

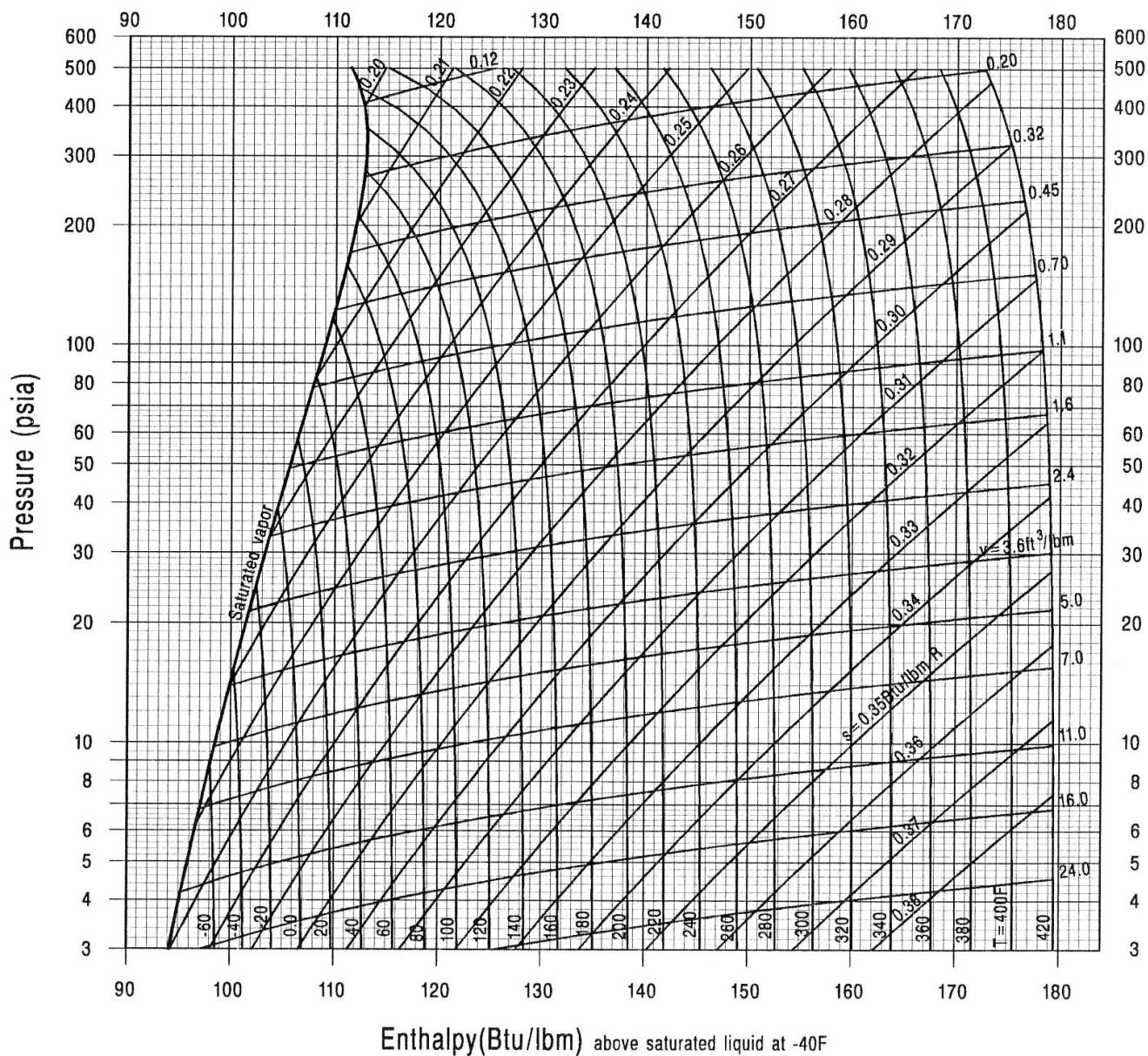
Temp. °C	Pressure MPa	Liquid Density kg/m ³ l/v _f	Vapor Sp. Vol. m ³ /kg v _g	Enthalpy, Datum -40 °C, kJ/kg		Entropy, Datum -40 °C, kJ/kg · K	
				Sat. Liquid h _f	Sat. Vapor h _g	Sat. Liquid s _f	Sat. Vapor s _g
0	0.4974	1284.8	0.04715	44.59	249.95	0.1751	0.9270
1	0.5138	1281.4	0.04569	45.76	250.31	0.1794	0.9255
2	0.5307	1278.0	0.04428	46.94	250.67	0.1836	0.9241
3	0.5479	1274.6	0.04293	48.12	251.03	0.1878	0.9226
4	0.5655	1271.1	0.04163	49.30	251.38	0.1920	0.9212
5	0.5836	1267.7	0.04037	50.48	251.73	0.1963	0.9198
6	0.6021	1264.2	0.03916	51.67	252.08	0.2005	0.9184
7	0.6210	1260.7	0.03799	52.87	252.42	0.2047	0.9170
8	0.6404	1257.1	0.03686	54.06	252.76	0.2089	0.9156
9	0.6602	1253.6	0.03577	55.26	253.09	0.2131	0.9143
10	0.6805	1250.0	0.03472	56.46	253.43	0.2173	0.9129
11	0.7012	1246.4	0.03371	57.67	253.75	0.2215	0.9116
12	0.7224	1242.8	0.03273	58.88	254.08	0.2257	0.9102
13	0.7441	1239.2	0.03179	60.09	254.39	0.2298	0.9089
14	0.7663	1235.5	0.03088	61.30	254.71	0.2340	0.9076
15	0.7889	1231.9	0.03000	62.52	255.02	0.2382	0.9062
16	0.8121	1228.2	0.02914	63.74	255.33	0.2424	0.9049
17	0.8357	1224.5	0.02832	64.97	255.63	0.2465	0.9036
18	0.8598	1220.7	0.02753	66.20	255.93	0.2507	0.9023
19	0.8845	1217.0	0.02676	67.43	256.22	0.2549	0.9011
20	0.9097	1213.2	0.02601	68.67	256.51	0.2590	0.8998
21	0.9354	1209.4	0.02529	69.91	256.79	0.2632	0.8985
22	0.9616	1205.5	0.02459	71.15	257.07	0.2673	0.8972
23	0.9884	1201.7	0.02392	72.40	257.35	0.2715	0.8960
24	1.0157	1197.8	0.02326	73.65	257.62	0.2756	0.8947
25	1.0436	1193.9	0.02263	74.91	257.88	0.2797	0.8934
26	1.0720	1189.9	0.02202	76.17	258.14	0.2839	0.8922
27	1.1011	1186.0	0.02142	77.43	258.39	0.2880	0.8909
28	1.1306	1182.0	0.02085	78.70	258.64	0.2921	0.8897
29	1.1608	1177.9	0.02029	79.99	258.88	0.2963	0.8884
30	1.1916	1173.9	0.01975	81.26	259.12	0.3004	0.8872
31	1.2229	1169.8	0.01922	82.53	259.35	0.3045	0.8859
32	1.2549	1165.7	0.01871	83.81	259.58	0.3087	0.8847
33	1.2874	1161.5	0.01822	85.11	259.80	0.3128	0.8834
34	1.3206	1157.3	0.01774	86.41	260.01	0.3169	0.8822
35	1.3544	1153.1	0.01727	87.72	260.22	0.3211	0.8809
36	1.3889	1148.8	0.01682	89.00	260.42	0.3252	0.8797
37	1.4240	1144.5	0.01638	90.31	260.61	0.3293	0.8784
38	1.4597	1140.2	0.01596	91.63	260.80	0.3334	0.8771
39	1.4961	1135.8	0.01554	92.94	260.98	0.3376	0.8759
40	1.5331	1131.4	0.01514	94.27	261.15	0.3417	0.8746
41	1.5709	1126.9	0.01475	95.60	261.32	0.3458	0.8734
42	1.6093	1122.4	0.01437	96.94	261.48	0.3500	0.8721
43	1.6483	1117.9	0.01400	98.28	261.63	0.3541	0.8708
44	1.6881	1113.3	0.01364	99.63	261.77	0.3583	0.8695
45	1.7286	1108.7	0.01329	100.98	261.90	0.3624	0.8682
46	1.7698	1104.0	0.01295	102.34	262.02	0.3666	0.8669
47	1.8117	1099.3	0.01262	103.71	262.14	0.3707	0.8656
48	1.8544	1094.5	0.01229	105.08	262.25	0.3749	0.8643
49	1.8977	1089.6	0.01198	106.46	262.34	0.3791	0.8629
50	1.9419	1084.8	0.01167	107.85	262.43	0.3832	0.8616
51	1.9867	1079.8	0.01137	109.24	262.51	0.3874	0.8602
52	2.0324	1074.8	0.01108	110.65	262.58	0.3916	0.8589
53	2.0788	1069.7	0.01080	112.06	262.63	0.3958	0.8575
54	2.1260	1064.6	0.01052	113.48	262.68	0.4000	0.8561
55	2.1740	1059.4	0.01025	114.91	262.71	0.4042	0.8546
56	2.2227	1054.1	0.00999	116.34	262.73	0.4085	0.8532
57	2.2723	1048.8	0.00974	117.79	262.74	0.4127	0.8517
58	2.3227	1043.4	0.00949	119.24	262.73	0.4170	0.8503
59	2.3740	1037.9	0.00924	120.71	262.71	0.4212	0.8488
60	2.4260	1032.3	0.00900	122.18	262.68	0.4255	0.8472

Pressure-Enthalpy Diagram for R22

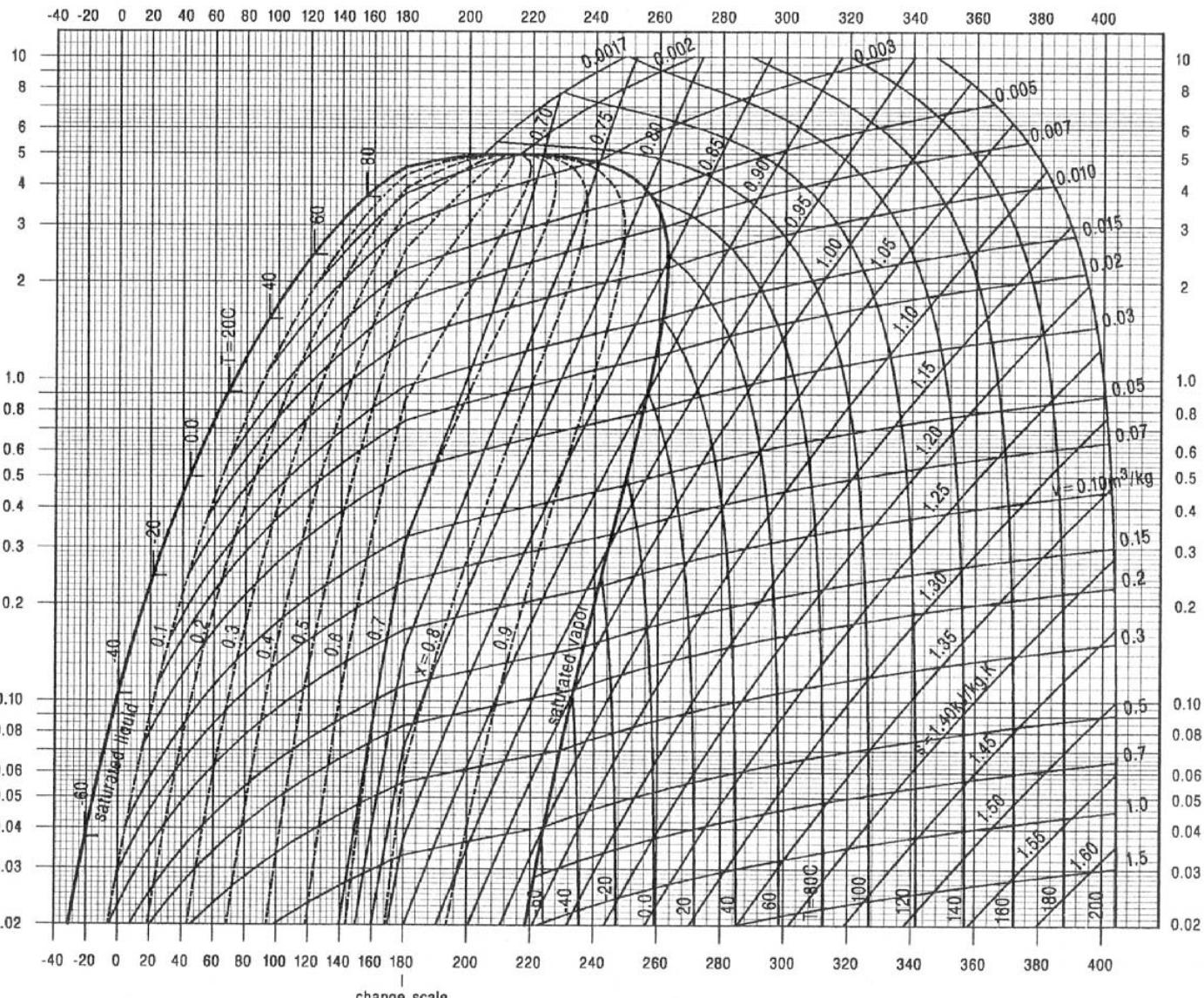


Enthalpy(Btu/lbm) above saturated liquid at -40F

Pressure-Enthalpy Diagram for R22



Pressure-Enthalpy Diagram for R22



Enthalpy(kJ/kg) above saturated liquid at -40C

Pressure-Enthalpy Diagram for R22

