



**UNIVERSITI KUALA LUMPUR  
MALAYSIA FRANCE INSTITUTE**

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**FINAL EXAMINATION  
JANUARY 2014 SESSION**

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**SUBJECT CODE : FRB30304**  
**SUBJECT TITLE : PRODUCTION OF REFRIGERATION**  
**LEVEL : BACHELOR**  
**TIME/DURATION : 9.00 am – 12:00 pm**  
**3 HOURS**  
**DATE : 28 MAY 2014**

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**INSTRUCTIONS TO CANDIDATES**

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- 1. All documents authorized (Open Book Examination)**
  - 2. Please read the instructions given in the question paper CAREFULLY.**
  - 3. This question paper is printed on both sides of the paper.**
  - 4. Please write your answers on the answer booklet provided.**
  - 5. Answer should be written in blue or black ink except for sketching, graphic and illustration.**
  - 6. This question paper consists only one section. Answer all questions.**
  - 7. Answer all questions in English.**
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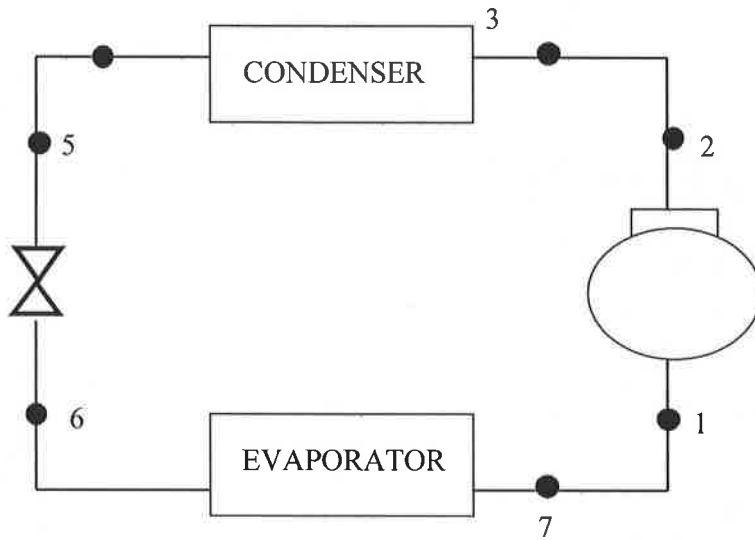
**THERE ARE 3 PRINTED PAGES OF QUESTIONS AND 7 PAGES OF APPENDICE, EXCLUDING THIS PAGE**

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**INSTRUCTION: Answer ALL questions.**  
**Please use the answer booklet provided.**

**PART A**

We use a single stage compressor with R134a to produce a refrigerating power under the following conditions as showing below:



Refrigerating power	$\dot{Q}_0 =$	75 kW
Temperature of evaporation	$\theta_E =$	-15 °C
Temperature of condensation	$\theta_C =$	44 °C
Superheat at exit of evaporator:	:	5 °C
Additional heating in the piping of suction	:	3 °C
Subcool of the liquid at exit condenser	:	4 °C
Extra cooling of the liquid before TXV	:	5 °C
Pressure drop for evaporator and condenser	:	1 °C

**Question 1**

To trace, in a diagram by a show of hands, the cycle describes by the refrigerant.

Hence, find  $h_6$ ,  $h_7$ ,  $h_{2is}$  and  $v_1$ .

(14 marks)

**Question 2**

Calculate the the volumetric efficiency and the effective efficiency for appendix 3.  
Given that all the compressors have same volumetric and effective efficiency,  
select compressors.

**[Note: please return this page together with answer booklet]**

(20 marks)

**Question 3**

If one compressor Model H selected, calculate the actual volume flow rate, mass flow rate  
and effective power of the compressor.

The thermal losses of the compressor are 10% of the effective power of the compressor.

Calculate the thermodynamic characteristic of point 2

(10 marks)

**Question 4**

Fill in the table of the thermodynamic co-ordinates in Appendix 4.

**[Note: please return this page together with answer booklet]**

(10 marks)

**PART B**

We want to produce 50kW to cool a brine (constant flow) with the mode  $-15^{\circ}\text{C} / -20^{\circ}\text{C}$ . We  
choose a cycle of partial injection with intermediate receiver. The conditions of the cold store  
are as follows:

Temperature of evaporation: $-25^{\circ}\text{C}$	superheat at exit of evaporator:	5 $^{\circ}\text{C}$
Temperature of condensation (maintained constant): $45^{\circ}\text{C}$	sub cooling:	2 $^{\circ}\text{C}$
Refrigerant is		R134a
Suction superheat of compressors is		5 K
intermediate temperature of saturation :		5 $^{\circ}\text{C}$
Temperature difference at exit of the intermediate bottle :		5 $^{\circ}\text{C}$

**Question 5**

To supplement the general diagram of appendix 6 (we will not represent the oil coolant circuit).

**[Note: Please return appendix 6]**

(6 marks)

**Question 6**

To trace, in a diagram by a show of hands, the cycle describes by the refrigerant.

(10 marks)

**Question 7**

If compressor model G is selected for compressor C1, volumetric efficiency of compressor is 0.7. Calculate the actual mass flow rate of low pressure compressor,  $\dot{m}_L$  mass flow rate of injection,  $\dot{m}_{inj}$  and mass flow rate of high pressure compressor,  $\dot{m}_H$

**[Note: User cycle in Appendix 5]**

(10 marks)

**Question 8**

Calculate the real cooling capacity of evaporator.

Calculate the value of the product  $\dot{m}_{frig} C_p$  and the total KS of the evaporator

(20 marks)

**END OF QUESTION**

Appendix 1: Table of R134a saturation

T (°C)	Saturated Liquid				Saturated Vapour			
	P (bar)	h (kJ/kg)	s (J/kg K)	v (dm <sup>3</sup> /kg)	P (bar)	h (kJ/kg)	s (J/kg K)	v (dm <sup>3</sup> /kg)
-45	0.386	141.98	768.06	0.6980	0.386	370.86	1772.2	464.67
-40	0.505	148.21	794.99	0.7050	0.505	374.02	1764.5	361.01
-35	0.653	154.47	821.65	0.7124	0.653	377.17	1757.6	283.94
-30	0.833	160.77	848.03	0.7199	0.833	380.31	1751.5	225.87
-25	1.050	167.13	874.12	0.7278	1.050	383.42	1746.0	181.55
-20	1.310	173.56	899.90	0.7360	1.310	386.51	1741.2	147.33
-15	1.618	180.06	925.37	0.7445	1.618	389.56	1736.9	120.61
-10	1.980	186.63	950.54	0.7534	1.980	392.58	1733.1	99.54
-5	2.402	193.27	975.41	0.7626	2.402	395.56	1729.7	82.76
0	2.890	200.00	1000.00	0.7723	2.890	398.49	1726.7	69.28
5	3.451	206.79	1024.32	0.7825	3.451	401.37	1724.1	58.35
10	4.092	213.65	1048.40	0.7932	4.092	404.19	1721.7	49.43
15	4.820	220.58	1072.27	0.8044	4.820	406.94	1719.6	42.08
20	5.642	227.59	1095.95	0.8163	5.642	409.61	1717.6	35.99
25	6.567	234.67	1119.50	0.8290	6.567	412.20	1715.8	30.91
30	7.601	241.83	1142.94	0.8425	7.601	414.69	1714.1	26.65
35	8.754	249.08	1166.33	0.8569	8.754	417.07	1712.4	23.04
40	10.033	256.43	1189.72	0.8724	10.033	419.33	1710.7	19.98
45	11.448	263.90	1213.17	0.8892	11.448	421.44	1709.0	17.36
50	13.007	271.52	1236.74	0.9075	13.007	423.38	1707.1	15.10
55	14.720	279.32	1260.51	0.9276	14.720	425.12	1704.9	13.15
60	16.598	287.33	1284.54	0.9499	16.598	426.63	1702.4	11.46

Appendix 2: Table of thermodynamic coordinates-page 1

T (°C)	P <sub>sat</sub> (Bar)	Superheated vapour (K)																		
		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85		
-45	0.3861	h(kJ/kg)	374.50	378.18	381.90	385.66	389.47	393.31	397.20	401.13	405.10	409.12	413.17	417.27	421.41	425.59	429.81	434.08	438.39	
		s(J/kg.K)	1787.94	1803.56	1819.02	1834.33	1849.51	1864.55	1879.46	1894.25	1908.93	1923.49	1937.94	1952.28	1966.53	1980.67	1994.72	2008.68	2022.54	2036.31
		v(m³/kg)	0.4757	0.4868	0.4977	0.5087	0.5195	0.5304	0.5412	0.5520	0.5627	0.5735	0.5842	0.5948	0.6055	0.6162	0.6268	0.6374	0.6480	0.6586
-40	0.5054	h(kJ/kg)	377.73	381.48	385.27	389.10	392.97	396.87	400.82	404.81	408.84	412.91	417.02	421.17	425.37	429.60	433.88	438.19	442.55	446.95
		s(J/kg.K)	1780.20	1795.78	1811.20	1826.47	1841.60	1856.59	1871.45	1886.19	1900.81	1915.31	1929.70	1943.99	1958.17	1972.26	1986.25	2000.15	2013.95	2027.65
		v(m³/kg)	0.3696	0.3781	0.3866	0.3950	0.4034	0.4117	0.4201	0.4284	0.4366	0.4449	0.4531	0.4613	0.4695	0.4777	0.4859	0.4940	0.5021	0.5102
-35	0.6528	h(kJ/kg)	380.96	384.78	388.64	392.53	396.46	400.43	404.45	408.49	412.58	416.71	420.88	425.09	429.34	433.63	437.95	442.32	446.73	451.19
		s(J/kg.K)	1773.31	1788.87	1804.25	1819.49	1834.58	1849.53	1864.35	1879.04	1893.61	1908.06	1922.40	1936.63	1950.76	1964.80	1978.73	1992.57	2006.32	2020.07
		v(m³/kg)	0.2907	0.2974	0.3040	0.3106	0.3172	0.3237	0.3302	0.3367	0.3431	0.3496	0.3560	0.3624	0.3688	0.3751	0.3815	0.3878	0.3942	0.4006
-30	0.8327	h(kJ/kg)	384.17	388.06	391.99	395.96	399.96	404.00	408.07	412.18	416.33	420.52	424.75	429.01	433.32	437.66	442.04	446.46	450.93	455.45
		s(J/kg.K)	1767.19	1782.73	1798.10	1813.31	1828.37	1843.29	1858.07	1872.72	1887.24	1901.65	1915.95	1930.14	1944.22	1958.20	1972.09	1985.88	1999.58	2013.19
		v(m³/kg)	0.2312	0.2365	0.2418	0.2471	0.2523	0.2575	0.2626	0.2677	0.2728	0.2779	0.2830	0.2881	0.2931	0.2981	0.3031	0.3081	0.3131	0.3181
-25	1.0501	h(kJ/kg)	387.36	391.34	395.34	399.38	403.45	407.55	411.69	415.87	420.08	424.33	428.62	432.94	437.30	441.70	446.14	450.61	455.13	459.69
		s(J/kg.K)	1761.75	1777.29	1792.66	1807.85	1822.89	1837.79	1852.54	1867.16	1881.65	1896.02	1910.28	1924.42	1938.46	1952.40	1966.24	1979.99	1993.64	2007.20
		v(m³/kg)	0.1859	0.1902	0.1944	0.1986	0.2028	0.2070	0.2111	0.2152	0.2193	0.2234	0.2274	0.2315	0.2355	0.2395	0.2435	0.2475	0.2515	0.2555
-20	1.3100	h(kJ/kg)	390.53	394.59	398.67	402.78	406.93	411.10	415.31	419.55	423.83	428.14	432.49	436.87	441.29	445.75	450.24	454.77	459.34	463.95
		s(J/kg.K)	1756.94	1772.49	1787.86	1803.06	1818.09	1832.96	1847.70	1862.29	1876.76	1891.10	1905.32	1919.43	1933.43	1947.33	1961.13	1974.83	1988.44	2001.96
		v(m³/kg)	0.1509	0.1544	0.1578	0.1613	0.1647	0.1680	0.1714	0.1747	0.1781	0.1814	0.1846	0.1879	0.1912	0.1944	0.1976	0.2009	0.2041	0.2073
-15	1.6180	h(kJ/kg)	393.68	397.82	401.98	406.17	410.39	414.64	418.92	423.23	427.57	431.94	436.35	440.80	445.28	449.79	454.34	458.93	463.55	468.21
		s(J/kg.K)	1752.69	1768.27	1783.65	1798.85	1813.88	1828.76	1843.48	1858.05	1872.50	1886.81	1901.01	1915.09	1929.06	1942.92	1956.68	1970.35	1983.92	1997.40
		v(m³/kg)	0.1235	0.1264	0.1293	0.1321	0.1349	0.1377	0.1404	0.1432	0.1459	0.1486	0.1513	0.1540	0.1566	0.1593	0.1619	0.1646	0.1672	0.1698
-10	1.9798	h(kJ/kg)	396.79	401.02	405.27	409.54	413.83	418.16	422.51	426.89	431.30	435.74	440.21	444.72	449.26	453.84	458.44	463.09	467.77	472.49
		s(J/kg.K)	1748.94	1764.56	1779.97	1795.19	1810.23	1825.10	1839.82	1854.39	1868.82	1883.12	1897.29	1911.34	1925.29	1939.12	1952.85	1966.48	1980.02	1993.47
		v(m³/kg)	0.1020	0.1044	0.1068	0.1091	0.1115	0.1138	0.1161	0.1183	0.1206	0.1228	0.1250	0.1273	0.1295	0.1316	0.1338	0.1360	0.1382	0.1404
-5	2.4016	h(kJ/kg)	399.87	404.19	408.52	412.88	417.26	421.66	426.08	430.54	435.02	439.53	444.07	448.64	453.24	457.87	462.54	467.24	471.98	476.75
		s(J/kg.K)	1745.63	1761.31	1776.76	1792.01	1807.07	1821.95	1836.67	1851.24	1865.66	1879.95	1894.11	1908.15	1922.06	1935.87	1949.58	1963.18	1976.69	1990.12
		v(m³/kg)	0.0848	0.0869	0.0889	0.0909	0.0928	0.0948	0.0967	0.0986	0.1005	0.1023	0.1042	0.1060	0.1079	0.1097	0.1115	0.1133	0.1151	0.1169
0	2.8898	h(kJ/kg)	402.90	407.32	411.75	416.19	420.65	425.13	429.64	434.16	438.72	443.30	447.90	452.54	457.21	461.90	466.63	471.39	476.19	481.01
		s(J/kg.K)	1742.73	1758.47	1773.98	1789.26	1804.35	1819.26	1833.99	1848.57	1862.99	1877.27	1891.42	1905.44	1919.34	1933.13	1946.81	1960.39	1973.87	1987.26
		v(m³/kg)	0.0710	0.0728	0.0745	0.0762	0.0778	0.0795	0.0811	0.0827	0.0843	0.0859	0.0874	0.0890	0.0905	0.0921	0.0936	0.0951	0.0966	0.0981
5	3.4509	h(kJ/kg)	405.89	410.41	414.93	419.47	424.02	428.58	433.17	437.77	442.40	447.05	451.73	456.43	461.16	465.92	470.71	475.54	480.39	485.27
		s(J/kg.K)	1740.17	1756.00	1771.57	1786.91	1802.04	1816.97	1831.73	1846.32	1860.75	1875.03	1889.17	1903.19	1917.08	1930.85	1944.52	1958.07	1971.53	1984.90
		v(m³/kg)	0.0599	0.0614	0.0628	0.0643	0.0657	0.0671	0.0685	0.0699	0.0712	0.0726	0.0739	0.0752	0.0765	0.0777	0.0791	0.0804	0.0817	0.0830
10	4.0919	h(kJ/kg)	408.82	413.45	418.08	422.71	427.35	432.00	436.67	441.35	446.05	450.78	455.53	460.30	465.10	469.93	474.78	479.66	484.58	489.54
		s(J/kg.K)	1737.92	1753.84	1769.49	1784.90	1800.08	1815.06	1829.84	1844.45	1858.89	1873.18	1887.33	1901.34	1915.23	1928.99	1942.64	1956.18	1969.62	1982.96
		v(m³/kg)	0.0508	0.0521	0.0533	0.0546	0.0558	0.0570	0.0582	0.0594	0.0605	0.0617	0.0628	0.0640	0.0651	0.0662	0.0673	0.0684	0.0695	0.0706
15	4.8199	h(kJ/kg)	411.69	416.44	421.17	425.90	430.64	435.38	440.13	444.90	449.68	454.49	459.31	464.15	469.02	473.91	478.83	483.78	488.75	493.74
		s(J/kg.K)	1735.92	1751.97	1767.71	1783.20	1798.44	1813.47	1828.29	1842.93	1857.39	1871.70	1885.85	1899.87	1913.75	1927.51	1941.15	1954.68	1968.10	1981.42
		v(m³/kg)	0.0433	0.0444	0.0455	0.0466	0.0477	0.0487	0.0497	0.0508	0.0518	0.0528	0.0538	0.0547	0.0557	0.0567	0.0576	0.0586	0.0595	0.0604

Appendix 2: Table of thermodynamic coordinates-page 2

R134a																				
T (°C)	P <sub>sat</sub> (Bar)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85		
20	5.6423	h(kJ/kg)	414.50	419.36	424.21	429.05	433.88	438.72	443.56	448.42	453.28	458.16	463.06	467.98	472.92	477.88	482.87	487.88	492.92	
		s(J/kg.K)	1.734.14	1.750.32	1.766.18	1.781.76	1.797.08	1.812.16	1.827.03	1.841.71	1.856.20	1.870.53	1.884.70	1.898.73	1.912.61	1.926.37	1.940.01	1.953.53	1.966.94	1.980.24
		v(m <sup>3</sup> /kg)	0.0370	0.0380	0.0390	0.0400	0.0409	0.0418	0.0427	0.0436	0.0445	0.0454	0.0462	0.0471	0.0479	0.0488	0.0496	0.0504	0.0512	0.0521
25	6.5668	h(kJ/kg)	417.23	422.22	427.19	432.14	437.08	442.02	446.95	451.90	456.85	461.81	466.78	471.78	476.79	481.82	486.88	491.95	497.06	502.21
		s(J/kg.K)	1.732.54	1.748.87	1.764.86	1.780.55	1.795.95	1.811.11	1.826.04	1.840.76	1.855.30	1.869.65	1.883.84	1.897.88	1.911.78	1.925.54	1.939.18	1.952.70	1.966.10	1.979.40
		v(m <sup>3</sup> /kg)	0.0318	0.0327	0.0336	0.0345	0.0353	0.0361	0.0369	0.0377	0.0385	0.0392	0.0400	0.0407	0.0415	0.0422	0.0429	0.0436	0.0443	0.0451
30	7.6013	h(kJ/kg)	419.88	425.01	430.10	435.17	440.22	445.26	450.30	455.33	460.37	465.42	470.47	475.54	480.63	485.74	490.86	496.01	501.18	506.36
		s(J/kg.K)	1.731.05	1.747.58	1.763.72	1.779.53	1.795.04	1.810.28	1.825.28	1.840.06	1.854.63	1.869.02	1.883.24	1.897.31	1.911.22	1.924.99	1.938.63	1.952.15	1.965.56	1.978.86
		v(m <sup>3</sup> /kg)	0.0275	0.0283	0.0291	0.0298	0.0306	0.0313	0.0320	0.0327	0.0334	0.0341	0.0347	0.0354	0.0360	0.0367	0.0373	0.0379	0.0386	0.0392
35	8.7538	h(kJ/kg)	422.42	427.71	432.94	438.14	443.30	448.45	453.59	458.72	463.85	468.98	474.13	479.28	484.44	489.62	494.82	500.03	505.27	510.52
		s(J/kg.K)	1.729.65	1.746.39	1.762.71	1.778.66	1.794.29	1.809.63	1.824.71	1.839.55	1.854.19	1.868.62	1.882.88	1.896.96	1.910.90	1.924.69	1.938.34	1.951.87	1.965.27	1.978.56
		v(m <sup>3</sup> /kg)	0.0238	0.0245	0.0252	0.0259	0.0266	0.0272	0.0279	0.0285	0.0291	0.0297	0.0303	0.0309	0.0315	0.0320	0.0326	0.0331	0.0337	0.0342
40	10.0330	h(kJ/kg)	424.87	430.31	435.69	441.02	446.31	451.58	456.82	462.06	467.28	472.51	477.74	482.97	488.21	493.47	498.74	504.03	509.34	514.66
		s(J/kg.K)	1.728.28	1.745.27	1.761.79	1.777.91	1.793.68	1.809.13	1.824.30	1.839.23	1.853.92	1.868.41	1.882.71	1.896.83	1.910.79	1.924.60	1.938.27	1.951.81	1.965.22	1.978.52
		v(m <sup>3</sup> /kg)	0.0207	0.0213	0.0220	0.0226	0.0232	0.0238	0.0244	0.0249	0.0255	0.0260	0.0265	0.0271	0.0276	0.0281	0.0286	0.0291	0.0296	0.0301
45	11.4475	h(kJ/kg)	427.18	432.81	438.35	443.83	449.25	454.64	460.00	465.34	470.66	475.98	481.30	486.62	491.95	497.28	502.63	508.00	513.37	518.74
		s(J/kg.K)	1.726.89	1.744.17	1.760.93	1.777.24	1.793.16	1.808.75	1.824.03	1.839.04	1.853.81	1.868.37	1.882.71	1.896.88	1.910.87	1.924.71	1.938.40	1.951.95	1.965.38	1.978.71
		v(m <sup>3</sup> /kg)	0.0180	0.0186	0.0192	0.0198	0.0203	0.0209	0.0214	0.0219	0.0224	0.0229	0.0233	0.0238	0.0243	0.0247	0.0252	0.0256	0.0260	0.0265
50	13.0067	h(kJ/kg)	429.36	435.19	440.91	446.54	452.11	457.62	463.10	468.55	473.99	479.40	484.82	490.23	495.64	501.06	506.49	511.92	517.38	522.84
		s(J/kg.K)	1.725.41	1.743.05	1.760.08	1.776.62	1.792.72	1.808.45	1.823.86	1.838.98	1.853.83	1.868.46	1.882.86	1.897.08	1.911.11	1.924.98	1.938.70	1.952.27	1.965.71	1.979.04
		v(m <sup>3</sup> /kg)	0.0157	0.0163	0.0168	0.0173	0.0179	0.0183	0.0188	0.0193	0.0197	0.0202	0.0206	0.0210	0.0214	0.0218	0.0222	0.0226	0.0230	0.0234
55	14.7201	h(kJ/kg)	431.37	437.43	443.34	449.15	454.87	460.52	466.13	471.70	477.24	482.77	488.28	493.78	499.28	504.79	510.30	515.81	521.34	526.87
		s(J/kg.K)	1.723.80	1.741.84	1.759.20	1.775.99	1.792.31	1.808.21	1.823.76	1.839.00	1.853.95	1.868.66	1.883.13	1.897.41	1.911.49	1.925.40	1.939.15	1.952.75	1.966.21	1.979.56
		v(m <sup>3</sup> /kg)	0.0137	0.0143	0.0148	0.0153	0.0157	0.0162	0.0166	0.0170	0.0174	0.0178	0.0182	0.0186	0.0190	0.0193	0.0197	0.0201	0.0204	0.0208
60	16.5979	h(kJ/kg)	433.20	439.51	445.65	451.64	457.53	463.34	469.08	474.78	480.44	486.07	491.68	497.28	502.88	508.47	514.06	519.66	525.27	530.87
		s(J/kg.K)	1.725.41	1.743.05	1.760.08	1.776.62	1.792.72	1.808.45	1.823.86	1.838.98	1.853.83	1.868.46	1.882.86	1.897.08	1.911.11	1.924.98	1.938.70	1.952.27	1.965.71	1.979.04
		v(m <sup>3</sup> /kg)	0.0157	0.0163	0.0168	0.0173	0.0179	0.0183	0.0188	0.0193	0.0197	0.0202	0.0206	0.0210	0.0214	0.0218	0.0222	0.0226	0.0230	0.0234

Appendix 3: Performance of compressors installed

**COMPRESSOR DATA**

Suction temperature : 20 °C  
 Sub Cooling : 0 °C  
 Compressor with swept volume 80 m<sup>3</sup>/h

Cooling Capacity (kW)

Tcond(°C)	T evaporation(°C)							
	5	0	-5	-10	-15	-20	-25	-30
-5				30.75	24.99	20.14	16.09	12.72
0			36.41	29.83	24.25	19.55	15.61	12.34
5		42.76	35.27	28.90	23.49	18.94	15.13	11.96
10	49.83	41.36	34.12	27.96	22.73	18.33	14.64	11.58
15	48.11	39.94	32.96	27.01	21.97	17.71	14.15	11.19
20	46.37	38.51	31.79	26.05	21.19	17.09	13.65	10.80
25	44.62	37.07	30.60	25.09	20.41	16.46	13.15	10.40
30	42.85	35.61	29.40	24.11	19.61	15.82	12.64	10.00
35	41.06	34.13	28.19	23.12	18.81	15.18	12.13	9.60
40	39.24	32.62	26.95	22.11	18.00	14.52	11.61	9.18
45	37.39	31.10	25.70	21.09	17.17	13.86	11.08	8.77
50	35.50	29.54	24.42	20.05	16.32	13.18	10.54	8.34
55	33.57	27.95	23.12	18.98	15.46	12.48	9.98	7.90
60	31.59	26.31	21.78	17.89	14.57	11.77	9.42	7.45

Absorbed Power (kW)

Tcond(°C)	T evaporation(°C)							
	5	0	-5	-10	-15	-20	-25	-30
-5				0.93	1.57	1.97	2.18	2.24
0			1.08	1.84	2.33	2.59	2.69	2.65
5		1.25	2.14	2.72	3.06	3.20	3.18	3.05
10	1.43	2.46	3.16	3.58	3.77	3.78	3.66	3.43
15	2.82	3.64	4.15	4.41	4.46	4.35	4.12	3.81
20	4.17	4.78	5.11	5.21	5.13	4.90	4.57	4.18
25	5.47	5.89	6.04	5.99	5.78	5.44	5.01	4.53
30	6.73	6.96	6.94	6.75	6.41	5.96	5.44	4.87
35	7.95	7.99	7.82	7.48	7.02	6.46	5.85	5.21
40	9.13	9.00	8.67	8.19	7.61	6.95	6.25	5.53
45	10.27	9.97	9.49	8.88	8.18	7.42	6.64	5.85
50	11.38	10.91	10.28	9.55	8.74	7.88	7.01	6.15
55	12.44	11.81	11.05	10.19	9.28	8.33	7.38	6.45
60	13.47	12.69	11.79	10.82	9.80	8.76	7.74	6.74

Model	A	B	C	D	E	F	G	H
Swept Volume	76.2	115	127	150	177.8	200	280	350



Appendix 4: Table of characteristic

POINT	1	2 <sub>is</sub>	2	3	4	5	6	7
Tsat (°C)								
P(Bar)								
T(°C)								
h(kJ/kg)								
s(kJ/kg.K)								
v(dm <sup>3</sup> /kg)								

Appendix 5: Table of characteristic for PART B

Part B  
User cycle

R134a

	1	2	3	4	5	6	7	8	9
Tsat	-25	5	5	45	45	45	-25	-25	5
P (Bar)	1.05	3.45	3.45	11.45	11.45	11.45	1.05	1.05	3.45
T (°C)	-20	112.52	124.71	167.43	182.017	43	-25	-20	10
H(kJ/kg)	387.36	502.65	514.98	554.32	570.66	260.90	213.65	387.36	405.89
s(kJ/kg.K)	1.7618	1.7618	2.0625	2.0625					
v (dm <sup>3</sup> /kg)	185.88		90.427						

Appendix 6 General Diagram

