Document No : UniKL MFI_SO_A041
Revision No: 01
Effective Date: 11 August 2008

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SET A

UNIVERSITI KUALA LUMPUR

MALAYSIA FRANCE INSTITUTE

FINAL EXAMINATION

JANUARY 2014 SESSION

SUBJECT CODE	:	FRB 10402
SUBJECT TITLE	:	REFRIGERATION FLUID
LEVEL	:	BACHELOR
TIME/DURATION	:	3 HOURS 3.30 pm - 6.30 pm
DATE	:	28 MAY 2014

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer two(2) question only.
6. Answer all questions in English.
7. Periodic Table is Appended (RETURNABLE)

THERE ARE 4 PRINTED PAGES OF QUESTIONS EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

QUESTION 1

(a) What is the main function of refrigerant in Air Conditioning System?

(3 marks)

(b) List seven (7) desired properties of refrigerant?

(7 marks)

QUESTION 2

(a) Refrigerants are believed to contribute to two major global environmental phenomena. Name them.

(3 marks)

(b) Describe the process of ozone depletion potential.

(3 marks)

(c) Explain 4 possible effects of ozone depletion.

(4 marks)

(c) What is the name of the international treaty which controls the production of certain refrigerants due to their ability to reduce the ozone layer? What is the outcome of this treaty to Air Conditioning Industries.

(4 marks)

QUESTION 3

Consider a refrigerator using R134a as the working fluid and operate at ambient temperature 35^0C.

(a) Determine the minimum pressure to which the refrigerant should be compressed (Notes: Refer to Appendix 1)

(3 marks)

(b) From answer (a) explain why

(3 marks)

QUESTION 4

(a) What is the greenhouse effect and how do refrigerants affect it?

(3 marks)

(b) Name three (3) natural greenhouse gasses

(3 marks)

(c) What are the two (2) components of Total Equivalent Warming Impact (TEWI)? Explain them.

(4 marks)

QUESTION 5

(a) What is standard color code of R22, R134a, R410A and R123 refrigerant cylinder respectively?

(3 marks)

(b) Sketch molecular structure and state the scientific name of R22 and R134a

(3 marks)

(c) Compare the advantages and disadvantages of R11, R22 and R410A

(4 marks)

QUESTION 6

Recovery process of a refrigerant for refrigeration system

(a) What is it?

(3 marks)

(b) Why is it important?

(3 marks)

(c) Explain its procedure

(4 marks)

Section B: (Total:40 marks)

INSTRUCTION: Answer only TWO questions.
Please use the answer booklet provided.

Question 7

A CFC-12 chiller is analyzed (based on a 100 year time frame), 10% of which is due to leaks and poor service practices which allow refrigerant to escape into the atmosphere. The unit is retrofitted to use HFC-134a. Leaks are repaired and it is noted that refrigerant loss has been cut in half with HFC-134a chiller. What is the TEWI of the CFC-12 chiller? What is the TEWI of retrofitted machine if the recovery efficiency increases by 10% (over the CFC-12 baseline)? (Assume: CFC-12 chiller recovery efficiency is 0.8. Compressor and auxillary electicity is 100 Kw and 30 Kw respectively running 8 hrs per day for both chiller. System operational at 20 years and Carbon Dioxide emission factor is 0.6kg CO2/kwh).

(20 marks)

QUESTION 8

(a) Why is it important to develop a long range refrigerant management plan?

(5 marks)

(b) What are the three elements of a refrigerant management plan?

(5 marks)

(c) The existing chiller (2 000 kW) average energy consumption is 0.23 kW_E/kW_R. If the cost of a new chiller (installation, sensor, refrigerant) is RM 1 000 000.00. Will the owner replace the new chiller (2 000 kW) using an alternative refrigerant 0.18 kW_E/kW_R? The condition is payback period must less than 5 years. Assume the chiller run 8 hours everyday with equivalent full load is 0.75 and cost of electricity is RM 0.328/kW-hr.

(10 marks)

QUESTION 9

(a) Define refrigerant safety classification ASHRAE 34 that is A1, A2, A3, B1, B2 and B3.

(5 marks)

(b) Give 3 examples for each group in question (a).

(5marks)

(c) Describe the advantage and disadvantage of CO2, Propane and Ammonia.

(10 marks)

END OF QUESTION

Appendix 1

Table of saturated values for: R22, CHClF2, Chlorodifluoromethane

T °C	p Bar	v_l dm^3/kg	v_g m^3/kg	h_l kJ/kg	h_g kJ/kg	R kJ/kg	s_l kJ/(kg K)	s_g kJ/(kg K)
20.00	9.099	0.8243	0.02601	224.07	411.93	187.86	1.0839	1.7247
21.00	9.356	0.8269	0.02529	225.31	412.21	186.90	1.0880	1.7234
22.00	9.619	0.8295	0.02459	226.56	412.49	185.94	1.0922	1.7221
23.00	9.887	0.8322	0.02391	227.80	412.77	184.96	1.0963	1.7209
24.00	10.160	0.8349	0.02326	229.05	413.03	183.98	1.1005	1.7196
25.00	10.439	0.8376	0.02263	230.31	413.30	182.99	1.1046	1.7183
26.00	10.723	0.8404	0.02201	231.57	413.56	181.99	1.1087	1.7171
27.00	11.014	0.8432	0.02142	232.83	413.81	180.98	1.1129	1.7158
28.00	11.309	0.8461	0.02084	234.10	414.06	179.96	1.1170	1.7146
29.00	11.611	0.8490	0.02029	235.37	414.30	178.93	1.1211	1.7133
30.00	11.919	0.8519	0.01974	236.65	414.54	177.89	1.1253	1.7121
31.00	12.232	0.8549	0.01922	237.93	414.77	176.84	1.1294	1.7108
32.00	12.552	0.8579	0.01871	239.22	415.00	175.78	1.1335	1.7096
33.00	12.878	0.8610	0.01822	240.51	415.22	174.71	1.1377	1.7083
34.00	13.210	0.8641	0.01774	241.80	415.43	173.63	1.1418	1.7071
35.00	13.548	0.8673	0.01727	243.10	415.64	172.54	1.1459	1.7058
36.00	13.892	0.8705	0.01682	244.41	415.84	171.43	1.1500	1.7046
37.00	14.243	0.8738	0.01638	245.71	416.03	170.32	1.1542	1.7033
38.00	14.601	0.8771	0.01595	247.03	416.22	169.19	1.1583	1.7021
39.00	14.965	0.8805	0.01554	248.35	416.40	168.05	1.1624	1.7008
40.00	15.335	0.8839	0.01514	249.67	416.57	166.90	1.1666	1.6995
41.00	15.712	0.8874	0.01475	251.00	416.74	165.73	1.1707	1.6983
42.00	16.097	0.8909	0.01437	252.34	416.89	164.55	1.1748	1.6970
43.00	16.487	0.8946	0.01400	253.68	417.04	163.36	1.1790	1.6957
44.00	16.885	0.8983	0.01364	255.03	417.18	162.15	1.1831	1.6944
45.00	17.290	0.9020	0.01329	256.38	417.32	160.93	1.1873	1.6931
46.00	17.702	0.9058	0.01295	257.74	417.44	159.70	1.1914	1.6918
47.00	18.121	0.9097	0.01261	259.11	417.56	158.45	1.1956	1.6905
48.00	18.548	0.9137	0.01229	260.49	417.66	157.18	1.1998	1.6892
49.00	18.982	0.9178	0.01198	261.87	417.76	155.90	1.2039	1.6878
50.00	19.423	0.9219	0.01167	263.25	417.85	154.60	1.2081	1.6865

Appendix 2

Table of saturated values for: R134a, CH2FCF3, 1,1,1,2-tetrafluoroethane

T °C	p Bar	v_l dm³/kg	v_g m³/kg	h_l kJ/kg	h_g kJ/kg	R kJ/kg	s_l kJ/(kg K)	s_g kJ/(kg K)
10.00	4.145	0.7927	0.04913	213.44	402.89	189.45	1.0480	1.7170
11.00	4.286	0.7949	0.04756	214.80	403.44	188.64	1.0527	1.7166
12.00	4.429	0.7971	0.04604	216.17	404.00	187.83	1.0575	1.7162
13.00	4.577	0.7994	0.04458	217.54	404.55	187.01	1.0623	1.7158
14.00	4.728	0.8016	0.04318	218.92	405.10	186.18	1.0670	1.7154
15.00	4.883	0.8039	0.04183	220.30	405.64	185.34	1.0718	1.7150
16.00	5.042	0.8062	0.04052	221.68	406.18	184.50	1.0765	1.7146
17.00	5.204	0.8085	0.03927	223.07	406.72	183.66	1.0813	1.7142
18.00	5.371	0.8109	0.03806	224.44	407.26	182.82	1.0859	1.7139
19.00	5.541	0.8133	0.03690	225.84	407.80	181.96	1.0907	1.7135
20.00	5.716	0.8157	0.03577	227.23	408.33	181.09	1.0954	1.7132
21.00	5.895	0.8182	0.03469	228.64	408.86	180.22	1.1001	1.7128
22.00	6.078	0.8206	0.03365	230.05	409.38	179.34	1.1049	1.7125
23.00	6.265	0.8231	0.03264	231.46	409.91	178.45	1.1096	1.7122
24.00	6.457	0.8257	0.03166	232.87	410.42	177.55	1.1143	1.7118
25.00	6.653	0.8283	0.03072	234.29	410.94	176.65	1.1190	1.7115
26.00	6.853	0.8309	0.02982	235.72	411.45	175.73	1.1237	1.7112
27.00	7.058	0.8335	0.02894	237.15	411.96	174.81	1.1285	1.7109
28.00	7.267	0.8362	0.02809	238.58	412.47	173.89	1.1332	1.7106
29.00	7.482	0.8389	0.02727	240.02	412.97	172.95	1.1379	1.7103
30.00	7.701	0.8416	0.02648	241.46	413.47	172.00	1.1426	1.7100
31.00	7.924	0.8444	0.02572	242.91	413.96	171.05	1.1473	1.7097
32.00	8.153	0.8473	0.02498	244.36	414.45	170.09	1.1520	1.7094
33.00	8.386	0.8501	0.02426	245.82	414.94	169.12	1.1567	1.7091
34.00	8.625	0.8530	0.02357	247.28	415.42	168.14	1.1614	1.7088
35.00	8.868	0.8560	0.02290	248.75	415.90	167.15	1.1661	1.7085
36.00	9.117	0.8590	0.02225	250.22	416.37	166.15	1.1708	1.7082
37.00	9.371	0.8620	0.02162	251.70	416.84	165.14	1.1755	1.7079
38.00	9.630	0.8651	0.02102	253.18	417.30	164.12	1.1802	1.7077
39.00	9.894	0.8682	0.02043	254.67	417.76	163.09	1.1849	1.7074
40.00	10.164	0.8714	0.01986	256.16	418.21	162.05	1.1896	1.7071
41.00	10.439	0.8747	0.01930	257.66	418.66	161.00	1.1943	1.7068
42.00	10.720	0.8779	0.01877	259.16	419.11	159.94	1.1990	1.7065
43.00	11.007	0.8813	0.01825	260.67	419.54	158.87	1.2037	1.7062
44.00	11.299	0.8847	0.01774	262.19	419.98	157.79	1.2084	1.7059
45.00	11.597	0.8882	0.01726	263.71	420.40	156.69	1.2131	1.7056
46.00	11.901	0.8917	0.01678	265.24	420.83	155.59	1.2178	1.7053
47.00	12.211	0.8953	0.01632	266.77	421.24	154.47	1.2225	1.7050
48.00	12.526	0.8989	0.01588	268.32	421.65	153.33	1.2273	1.7047
49.00	12.848	0.9026	0.01544	269.86	422.05	152.19	1.2320	1.7044
50.00	13.176	0.9064	0.01502	271.42	422.44	151.03	1.2367	1.7041
51.00	13.510	0.9103	0.01461	272.98	422.83	149.85	1.2414	1.7037
52.00	13.851	0.9142	0.01421	274.55	423.21	148.66	1.2462	1.7034
53.00	14.198	0.9182	0.01383	276.13	423.59	147.46	1.2509	1.7030
54.00	14.552	0.9223	0.01345	277.71	423.95	146.24	1.2557	1.7027
55.00	14.912	0.9265	0.01309	279.30	424.31	145.01	1.2604	1.7023
56.00	15.278	0.9308	0.01273	280.90	424.66	143.75	1.2652	1.7019
57.00	15.652	0.9351	0.01239	282.51	424.99	142.49	1.2700	1.7015
58.00	16.032	0.9396	0.01205	284.13	425.32	141.20	1.2747	1.7011
59.00	16.419	0.9441	0.01172	285.75	425.64	139.89	1.2795	1.7007
60.00	16.813	0.9488	0.01141	287.39	425.96	138.57	1.2843	1.7003
61.00	17.215	0.9536	0.01110	289.03	426.26	137.23	1.2892	1.6998
62.00	17.623	0.9585	0.01079	290.68	426.54	135.86	1.2940	1.6994
63.00	18.039	0.9635	0.01050	292.35	426.82	134.47	1.2988	1.6989
64.00	18.462	0.9687	0.01021	294.02	427.09	133.07	1.3037	1.6983
65.00	18.893	0.9739	0.00993	295.71	427.34	131.63	1.3085	1.6978

Printed: 06/03/09, 15:08. Reference: D.P.Wilson & R.S.Basu, ASHRAE Transactions 1988, Vol. 94 part 2. Page: 1

Appendix 3

TEWI - Standard Method of Calculation

TEWI
Standard Method of Calculation

Job Reference: .... Date:.....

INPUT DATA

Application Sector: [ ] 1

Refrigerant Fluid : R- [ ] 2

Refrigerant Charge: [ ] kg 3

Annual Energy Consumption (kWh)

Compressors: [ ] 4

Ancillary: [ ] 5

SECTORAL FACTORS

System Operational Lifetime [ ] yr 6

Refrigerant GWP: [ ] 7

L1 [ ] 8 S1 [ ] 10

L2 [ ] 9 S2 [ ] 11

Recovery Efficiency [ ] 12

CO2 Emission Factor, ß (kg CO2/kWh) [ ] 13

TEWI CALCULATION

a) Direct Effect

Refrigerant Loss (Operational) = (3)x(6)x(8+9+10+11)/100 [ ] 14

Refrigerant Loss (Retirement) = (3)x(1.00-(12)) [ ] 15

Total Lifetime Refrigerant Loss (kg) = (14) + (15) [ ] 16

CO2 Equivalent (kg) = (16)x(7) [ ] 17

b) Indirect Effect

Indirect Effect (kg CO2) = ((4)+(5))x(13)x(6) [ ] 18

c) TEWI

TEWI = (17)+(18) [ ] kg CO2

= (17)+(18)/1000 [ ] Tonne CO2