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UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2010 SESSION

SUBJECT CODE	:	FRB 30203
SUBJECT TITLE	:	APPLIED THERMODYNAMICS
LEVEL	:	BACHELOR
TIME / DURATION	:	9.00am – 12.00pm (3 HOURS)
DATE	:	04 MAY 2010

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 questions paper consists of FOUR (4) questions. Answer ALL questions.
6. Answer ALL questions in English.
7. This is an Opened book examination.

THERE ARE 3 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

Discharge of a turbine (diagram of Mollier of water)

We consider a steam turbine with mass flow rate $\dot{m} = 1.2 kg/m^3$. The steam at the entry is at *T = 500°C* and *HP=100 bar*. We consider an expansion which is carried out between the HP and *a BP=1 bar* following two very different configurations:

1. Adiabatic expansion with an isentropic efficiency equal to η_s= 0,9,
2. Reversible isothermal expansion.

Answer these questions.

(a) To represent the two expansions on the Mollier diagram (Figure 1) and to return the sheet with the answer sheet.

(2.5 marks)

(b) To determine, in both cases:

I. The enthalpy of the exit point of the turbine.
II. To deduce the mechanical power from it.
III. To compare and comment on.

(2.5 marks)

Question 2

Cooled Compression (diagram of R-134a)

A cooled compressor inlet suction superheated vapour of R-134a coming from an evaporator. The inlet vapour is at a low pressure *BP=2 bar* and a $T_{suction}$=*30°C* temperature. On the installation, one measures the pressure as well as the temperature of discharge which is respectively: *HP=10 bar* and T_{dis} = *80°C*. The mechanical power absorbed by the compressor is also measured as $\dot{W} = 15kW$ and mass flow rate $\dot{m} = 0.3kg/s$. Answer these questions.

(a) To position the points of the vapour suction and discharge on the diagram of R-134a (Figure 2). (To return the figure with the answer sheet)

(2 marks)

(b) To write the first principle as applied for the compressor.

(1 mark)

(c) To deduce the cooling power from it $Q_{cooling}$.

(2 marks)

Question 3

Mixture

We wish to charge a mixture of CO_2/Propane (R-744/R-290) in an installation maintained at *θ_1=15°C starting* from a bottle, at θ2=*24°C*.

The charging bottle is thus at θ2=*24°C and* a pressure HP=40 bar, *it* is provided with a plunger tube making it possible to ensure the transfer in liquid phase towards the installation. The transfer is carried out until the pressure in the installation reaches *BP=25 bar*, this installation being maintained at θ1=*15°C*. Answer these questions.

(a) To locate on Figure 3 (to return the figure with the answer sheet) zones of pure liquid and pure vapour as well as the curves of dew and bubble of each spindle.

(1 mark)

(b) To calculate the concentrations in liquid phase and vapour phase in the bottle of supply *(HP=40 bar and θ2=24°C).*

(2 marks)

(c) To calculate the concentrations in liquid phase and vapour phase in the installation *(BP=25 bar and θ1=15°C*).

(2 marks)

Question 4

Air Refrigerating cycle: air-conditioning of a plane

The system of air-conditioning represented in Figure 4 is based on the inverse Joule cycle in which compression is carried out in the engine of the plane. Air necessary to air-conditioning is taken into 1 on the engine of the plane at high pressure HP and a high temperature (point 1 in Table 1). After cooling (point 2) at constant pressure, in an exchanger, by surrounding air, the air is expanded (point 3) to the LP in the turbine and it is injected into the cabin where it contributes to air-conditioning and pressurization of the cabin.

In the entire problem, we neglect the pressure losses and the air is regarded as a perfect gas (γ = *1,4 and Cp=1,115 kJ.kg-1.K-1*). The turbine is supposed to be adiabatic with isentropic efficiency equal to η_s = 0,85 . Answer these questions.

(a) To represent the isobars HP and LP and to hand trace part 1-2-3 of the cycle in the T-s diagram. (To return the figure with the answer sheet)

(b) To calculate temperature T3 of the exit point of the turbine

(c) To calculate the power, intended to run the fan, recovered on the turbine for an air flow $\dot{m} = 0{,}5\ kg\ /\ S$.

(d) The cabin the air enters at T3 and is heated to 23°C, to deduce the refrigerating power extracted of the process and to compare of it with recovered mechanical energy.

Table 1 Data of conditions of air refrigeration cycle

Point	P (bar)	T (°C)
1	3	400
2	3	77
3	1	

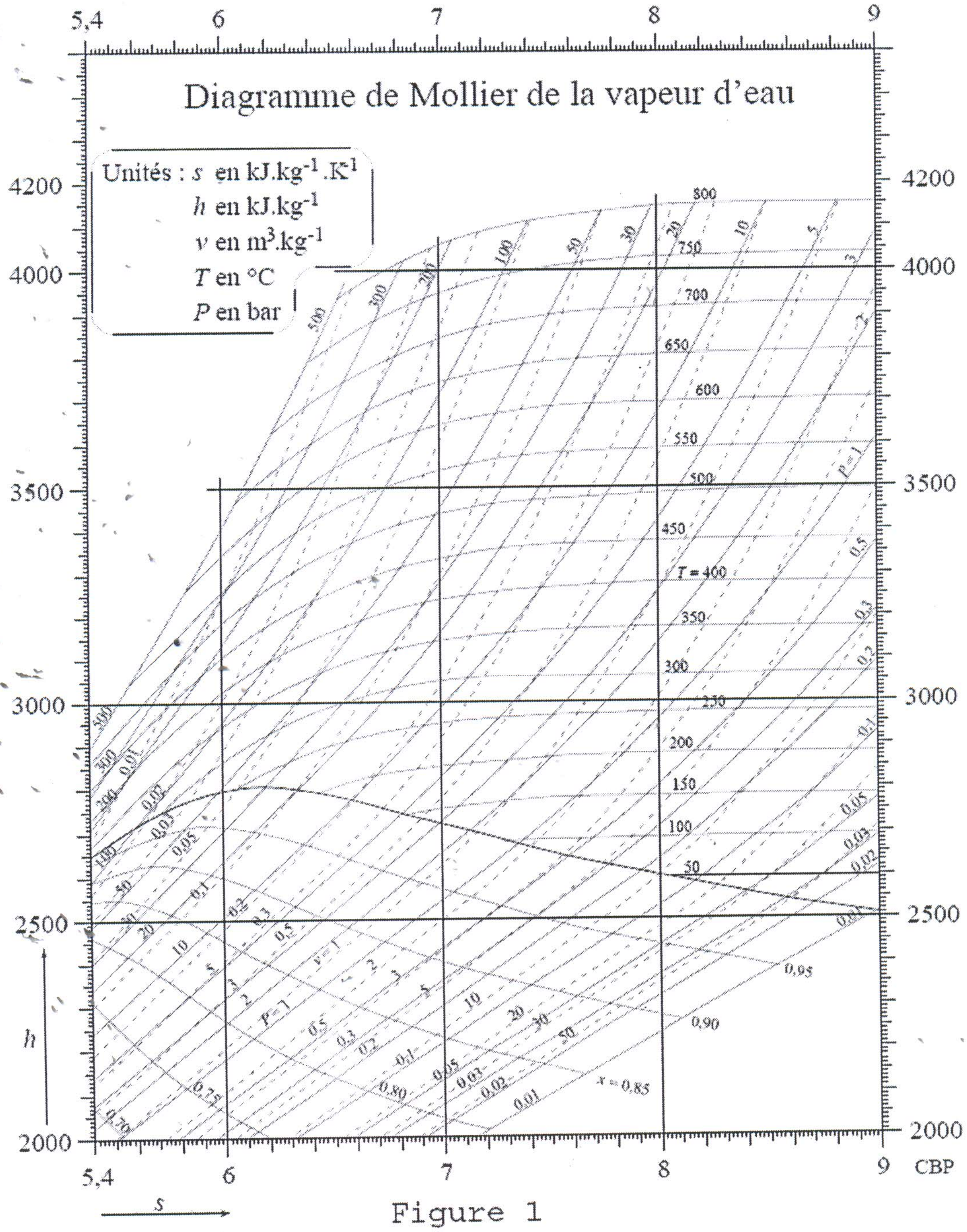
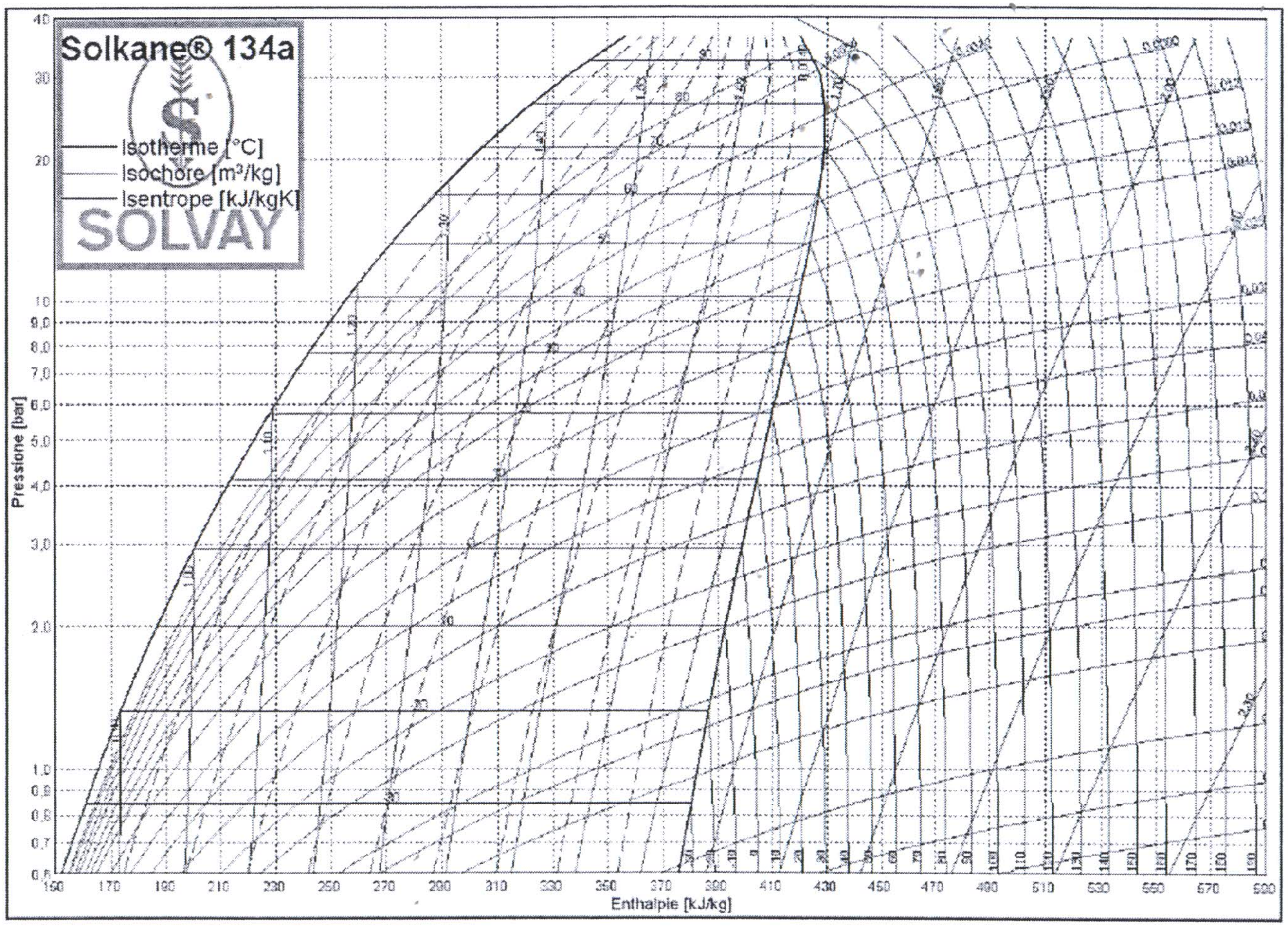


Diagramme de Mollier de la vapeur d'eau
Unités : s en kJ.kg-1.K-1
h en kJ.kg-1
v en m3.kg-1
T en °C
P en bar
5,4
6
7
8
9
4200
4000
3500
3000
2500
2000
h
s
CBP

Figure 1

Figure 2


Solkane® 134a
Isotherme [°C]
Isochore [m³/kg]
Isentrope [kJ/kgK]
SOLVAY
Pressione [bar]
Enthalpie [kJ/kg]
40
30
20
10
9,0
8,0
7,0
6,0
5,0
4,0
3,0
2,0
1,0
0,9
0,8
0,7
0,6
150
170
190
210
230
250
270
290
310
330
350
370
390
410
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490
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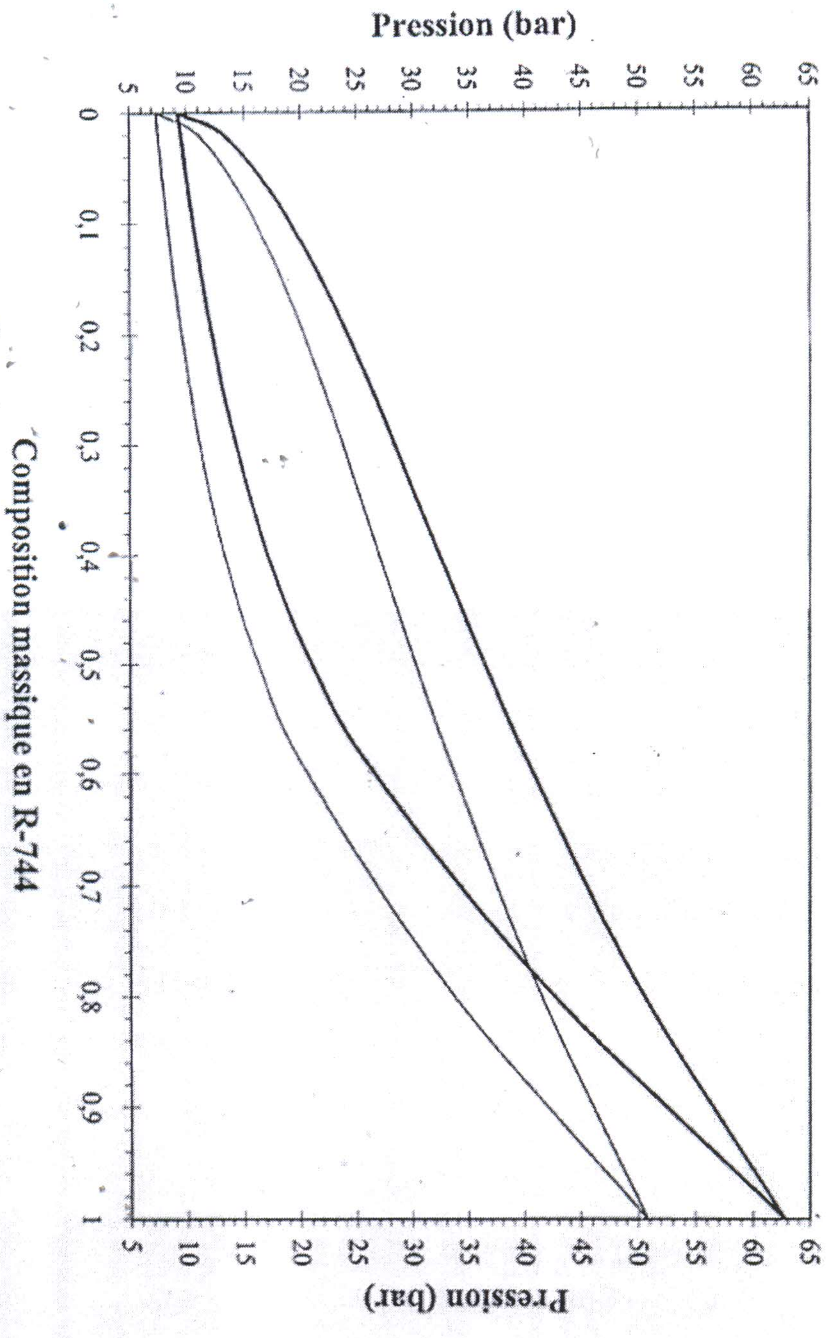

Figure 3 : Diagramme d'équilibre des phases du couple CO_2/Propane (R-744/R-290)

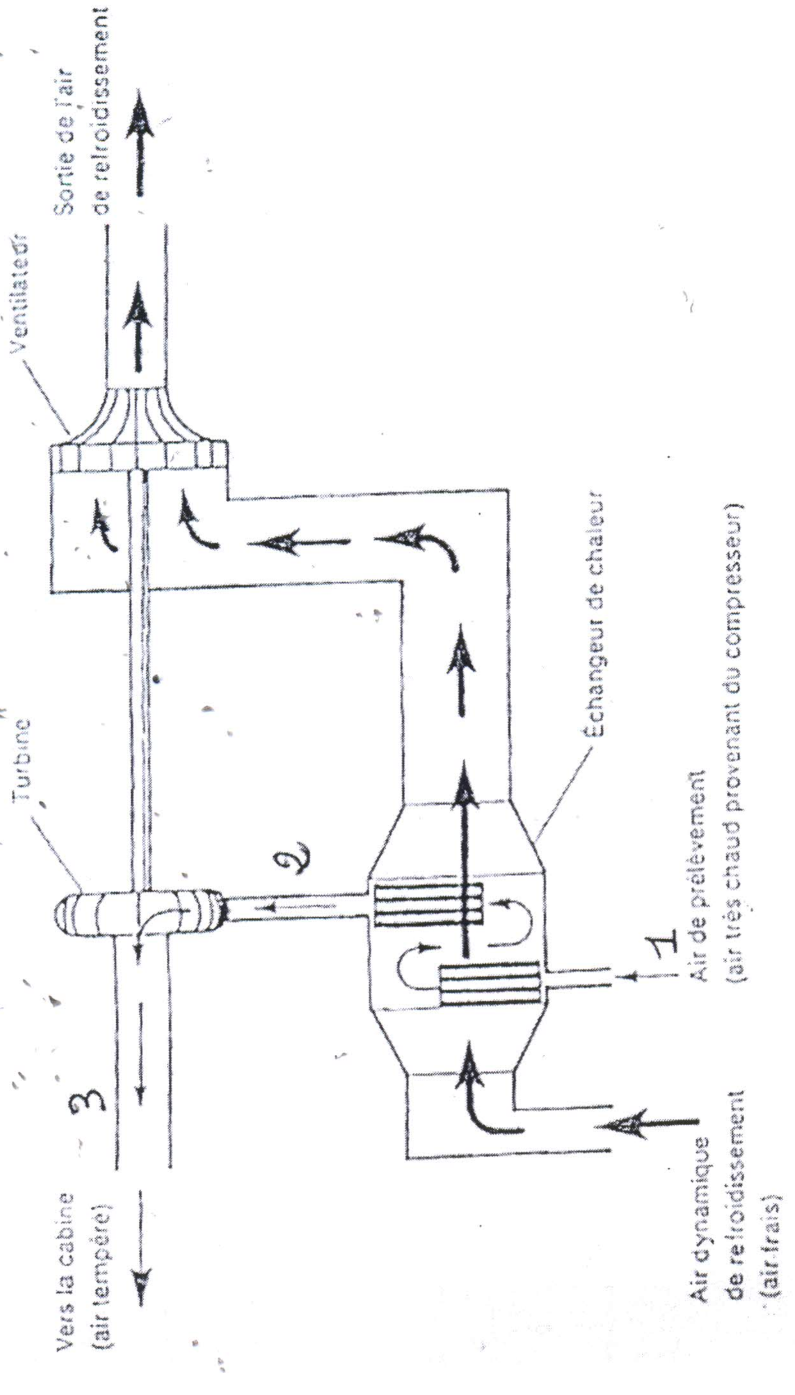

Figure 4
GROUPE TURBOREFROIDISSEUR
Climatisation d'un avion

END OF QUESTIONS