Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	TECHNOLOGY OF REFRIGERENT AND AIR CONDITIONING
COURSE CODE	:	BBA 20203
PROGRAMME CODE	:	BBG
EXAMINATION DATE	:	JULY 2024
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) What is the difference between temperature and pressure?

(3 marks)

(b) Phase change is a one of the effects of heat transfer. Describe the phase change process that effect heat transfer using relevant examples.

(9 marks)

(c) How much heat must be extracted from 8 kilograms of water initially at 140°C to transform it into ice at -3°C? Utilize the provided specific heat values from **Table Q1(c)** for your calculations. Additionally, illustrate the temperature versus energy graph based on your calculations.

Table Q1 (c): Specific heat values

Materials	Specific Heat (kJ/kg)
Water	4.19
Ice	2.11
Water vapor	2.00
Latent heat of vaporization	2260.00
Latent heat of melting	355.00

(13 marks)

Q2 (a) There are three (3) type of refrigerants. Explain in detail the advantages and disadvantages associated with utilizing Hydrocarbon (HC),Hydrofluorocarbon (HFC), and Hydrochlorofluorocarbon (HCFC) as refrigerants.

(6 marks)

(b) In many scenarios, it's preferable not to transport heat directly from the refrigerated space using the primary refrigerant, but rather to utilize a secondary refrigerant, such as brines. Discuss the primary benefits of employing secondary refrigerants (brines) in HVAC systems.

(5 marks)

(c) The HVAC system consists of 4 main components which are the compressor, condenser, thermal expansion valve, and evaporator. However, to further enhance the efficiency of the HVAC system, there are several additional components utilized by a system. Explain in detail the following three (3) additional components and their effects on the HVAC system.

(6 marks)

(d) There are four (4) types of air conditioning system which are air cooled packaged, water cooled packaged, air cooled chiller and water cooled chiller. With the help of a diagram, explain the difference of working principles between the water cooled packaged and air cooled packaged.

(8 marks)

Q3 A split unit system had its refrigerant changed from R32 to R290. One of the reason for this change is to enhance the system's efficiency and deduce energy costs. To demonstrate this, several data points were collected after the refrigerant replacement. The pressure at the evaporator is 0.20 MPa and the pressure of condenser is 0.8 MPa. Meanwhile, the temperature at compressor inlet is 20°C and temperature at condenser outlet at 10°C.

(a) By using suitable P-h diagram **Figure Q3(a)**, draw the cycle and identify the degree of superheat and sub-cooling.

(12 marks)

(b) Elaborate extensively on the process, temperature, pressure, and phase at every stage of the refrigerant, based on your cycle drawing in **Figure Q3(a).**

(5 marks)

(c) Based on the data from **Q3(a),** calculate;

i) Heat of compression

ii) Refrigeration effect

iii) Total heat rejection at condenser

iv) Compression ratio

(8 marks)

Q4 (a) Psychrometric chart serves as an analytical tool employed by HVAC engineers for resolving comfort-related concerns. Within a psychrometric chart, various terms are utilized to describe air properties. By using suitable graphs, sketch and explain these terms:

i) Drier Bulb

ii) Wet Bulb

iii) Humadity Ratio

iv) Specific Volume

v) Entalphy

(10 marks)

(b) A ceiling exposed unit is installed in a mosque. When it is turned on, the room temperature is 30 °C dry bulb and 80% relative humidity. By using psychrometric chart **Figure Q4 (b)**;

i) What is the humidity ratio in the room?

(2 marks)

ii) Utilizing the same psychrometric chart, determine the amount of moisture removed from the room over a few hours upon activating the air conditioning unit, resulting in a room temperature change to 20°C dry bulb temperature and 60% relative humidity.

(4 marks)

(c) During troubleshooting of the system, the technician operates the air conditioning unit for several hours. Utilizing the psychrometric chart provided in **Figure Q4(b),** complete the **Table Q4(c)** with the correct values.

Table Q4(c): Data for the Airconditioning system

	Dry bulb temperature	**Wet bulb temperature**	**Relative humidity**	**Dew point temperature**	**Humidity Ratio (g/Kg)**
A			40	6	
B	15.8	10			
C	25		38		

(9 marks)

- END OF QUESTIONS -

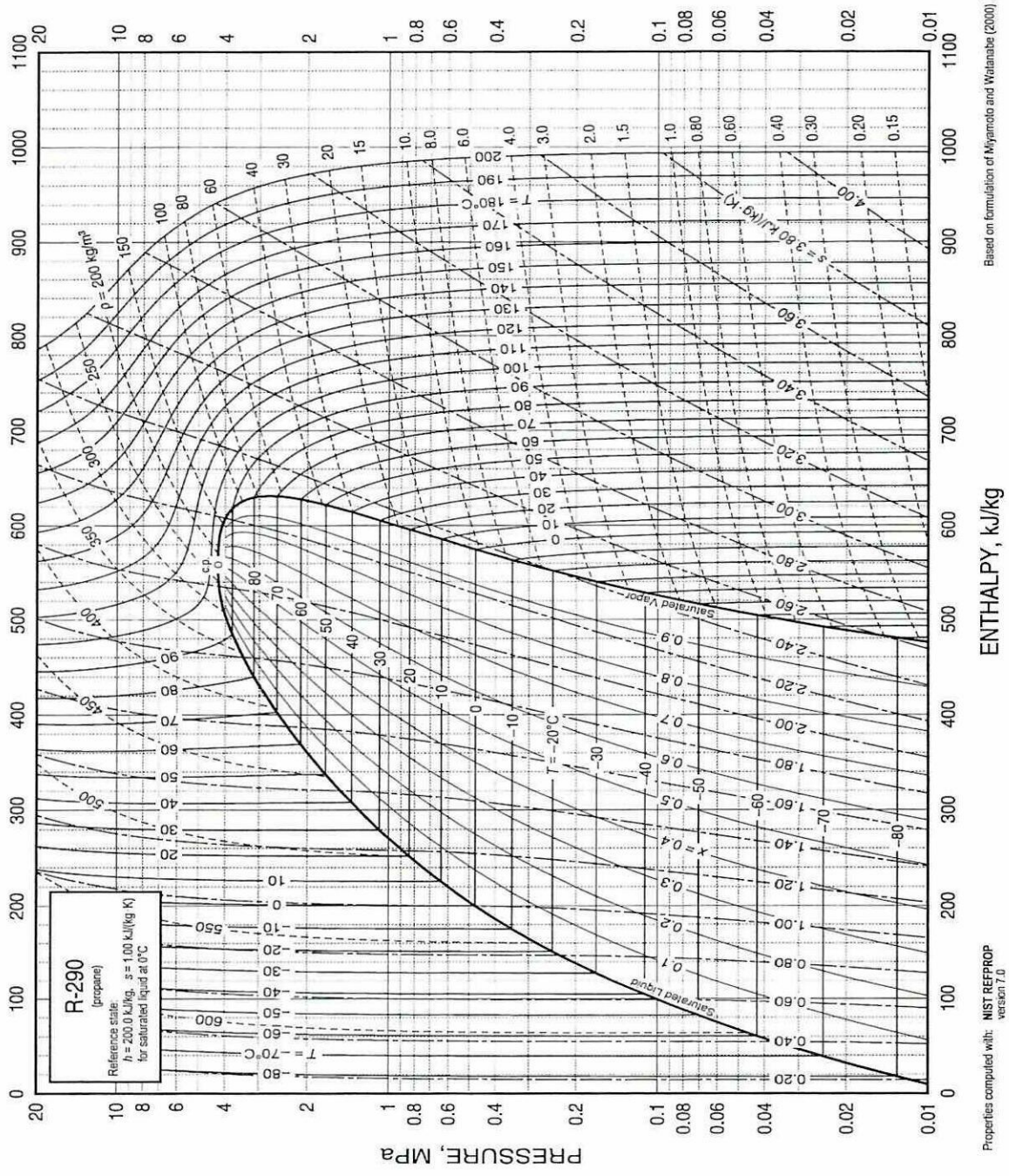

Figure Q3(a)

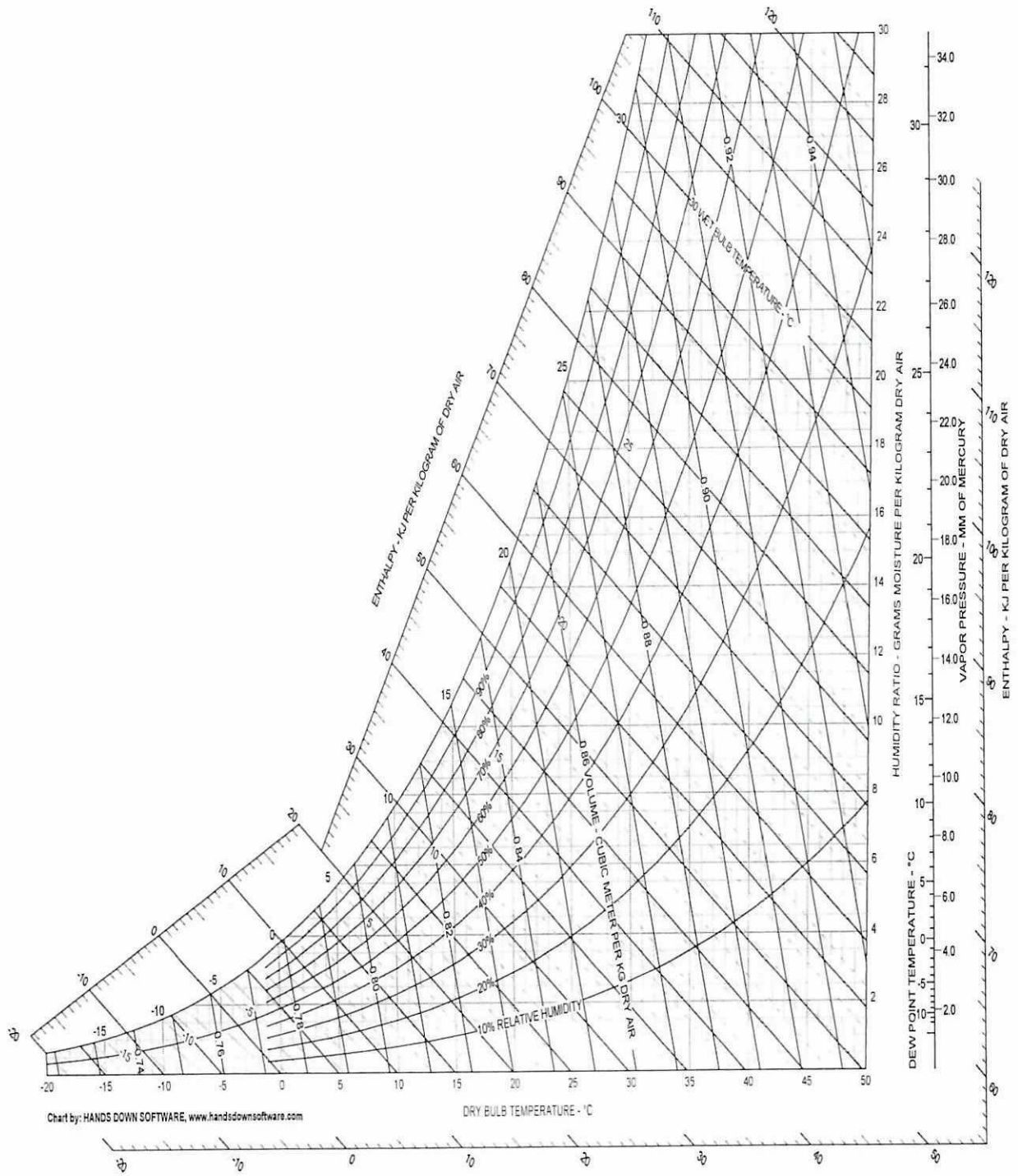

Figure Q4 (b)