National Exams May 2018

07-STR-B6: Building Engineering and Services

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   One of two calculators is permitted-any Casio or Sharp approved model.

3. FIVE (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

4. Each question is of equal value.

5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

Marking Scheme:

1. (1) 10 marks; (2) 4 marks; (3) 3 marks; (4) 3 marks
2. (1) 4 marks; (2) 4 marks; (3) 4 marks; (4) 4 marks; (5) 4 marks
3. (1) 10 marks; (2) 10 marks
4. 20 marks
5. (1) 5 marks; (2) 5 marks; (3) 5 marks; (4) 5 marks
6. (1) 8 marks; (2) 6 marks; (3) 6 marks

(20%) Question 1

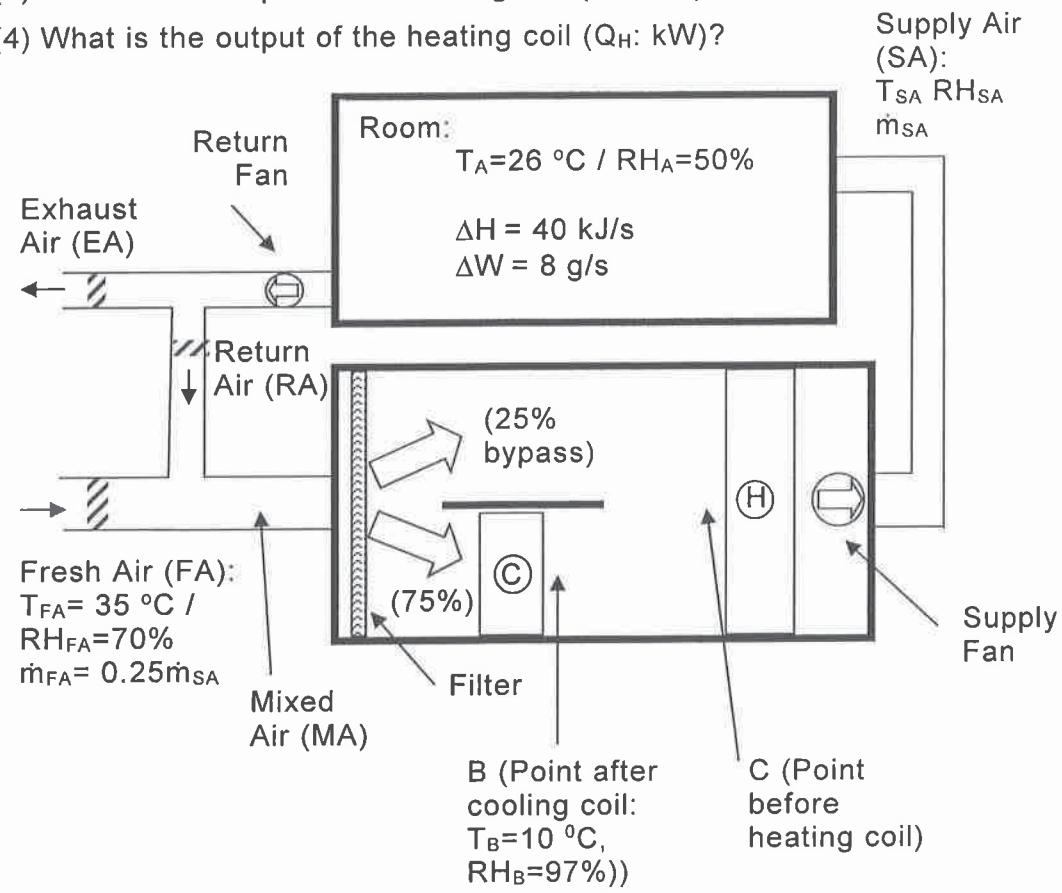
An air conditioning system is shown in the following figure. ΔH, ΔW are the total and moisture load of the space respectively. T, RH are dry-bulb temperature and relative humidity of humid air respectively. $\dot{m}$ is mass flow rate. Subscript: A – indoor air, SA – Supply Air, RA – Return Air, FA – Fresh Air, MA – Mixing Air, EA- Exhaust Air. Note: after MA (mixed air) passes through the filter in AHU, 25% goes through a bypass and 75% goes through a coiling coil. Then these two streams of humid air mixes before entering the heating coil. A Psychrometric Chart is provided.

(1) Present the air handling processes on the Psychrometric Chart and show the temperature and relative humidity of all key points (A, SA, MA, B,C).

(2) What is the total mass flow rate of the supply air $\dot{m}_{SA}$ (kg/s)?

(3) What is the output of the cooling coil (Q_C: kW)?

(4) What is the output of the heating coil (Q_H: kW)?



(20%) Question 2

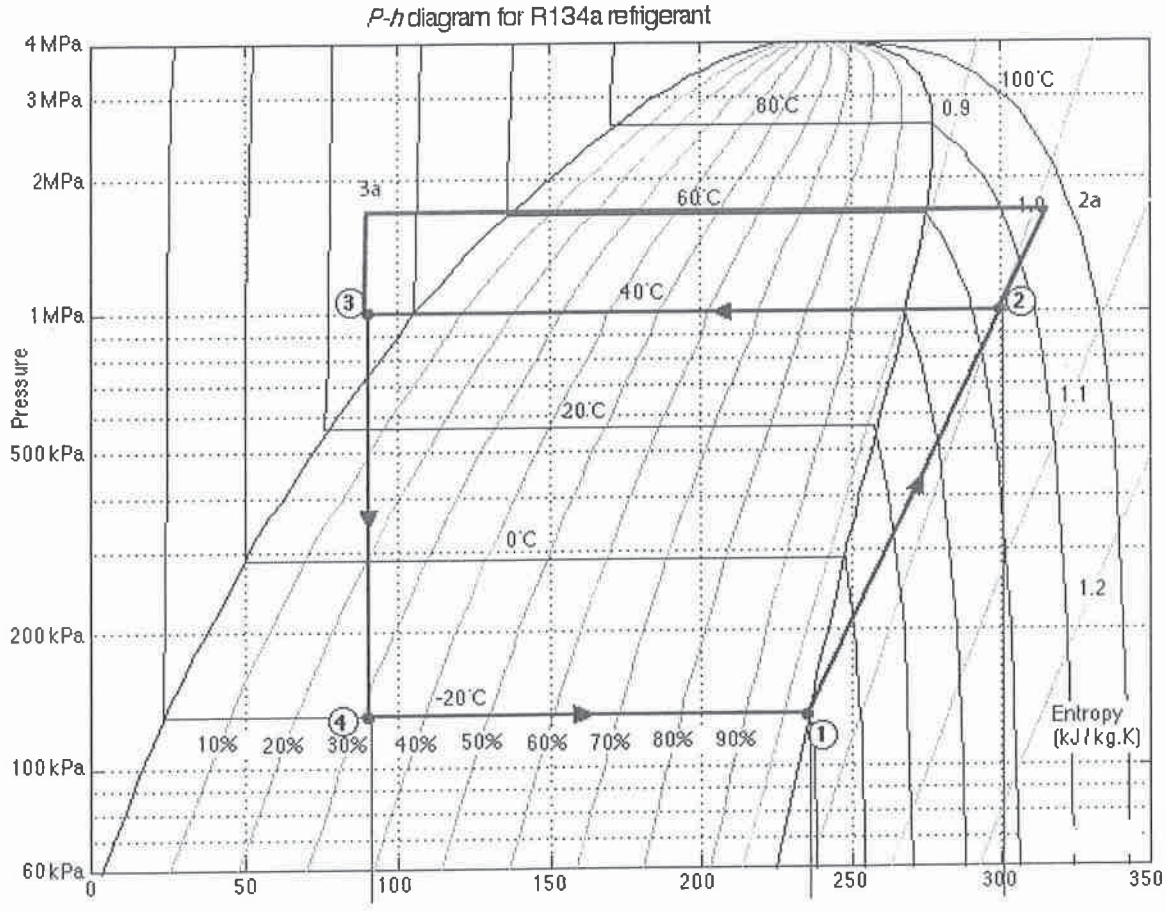
This is consisted of a series of small questions related room acoustics:

(1) What is the Reverberation Time of a room?
(2) What is the physical meaning of reverberation time being too high, and too low?
(3) What are the relevant variables that affect the value of the reverberation time of a space?
(4) What is the smallest increment of sound pressure level detectable by the human ear?
(5) What is the frequency range of sound that can be heard by human ear?

(20%) Question 3

The following shows the P-h diagram of a Refrigeration cycle based HVAC equipment with R134a. Please determine the ideal COP, actual COP and COP efficiency when:

(1) The evaporation temperature is -20°C, the condensation temperature is 40°C (Cycle: 4 -> 1 -> 2 -> 3 ->4)
(2) The evaporation temperature is -20°C, the condensation temperature is 60°C (Cycle: 4 -> 1 -> 2a -> 3a -> 4)



(20%) Question 4

A cavity wall is consisted of 13mm lightweight plaster, 120mm lightweight concrete block, 40mm mineral fibre slab, 10mm air space, and 100 mm brickwork. The indoor and outdoor air temperatures are 20 °C and -35 °C respectively. Calculate the temperature gradient through this wall.

Table of Given information

	Plaster	Concrete	Mineral fibre	Brickwork
Thermal conductivity (W/m.°K)	0.16	0.19	0.035	0.84
	Air space	Interior surface film	Exterior surface film	
Thermal resistance (m^2.°K/W)	0.18	0.12	0.06	

(20%) Question 5

This is consisted of a series of small questions:

(1) The resistance between the line and protective conductors is found to be 1.75 MΩ. What current would flow to earth during an insulation resistance test if a 500V DC e.m.f. is applied between the line and protective conductors?

(2) What is power factor? Why is it an issue for concern in electrical systems? At what value is it considered low and needs to be improved?

(3) Draw a diagram to illustrate how electricity is distributed on a construction site.

(4) Explain, by showing simple calculations, why the efficiency of long-distance electricity transmission is higher when higher voltage is used.

(20%) Question 6

A high-rise condominium building is conditioned by a fan-coil unit (FCU) based HVAC system. A two-pipe water distribution system distributes chilled water from a water-cooled chiller to the FCUs in the cooling season and hot-water from a natural gas-burning condensing boiler to the FCUs in the heating season. Within each residential unit, there is one FCU and a heat recovery ventilation unit (HRV).

(1) Draw a diagram (or a series of diagrams if you feel necessary) to illustrate the overall structure of such a system.

(2) Describe how the heat gains from the indoor space is transferred to the exterior environment through the HVAC system in the cooling season. You need describe all circulations of certain media, such as indoor air, chilled water, refrigerant, etc, through which heat is transferred, and name the key equipment involved.

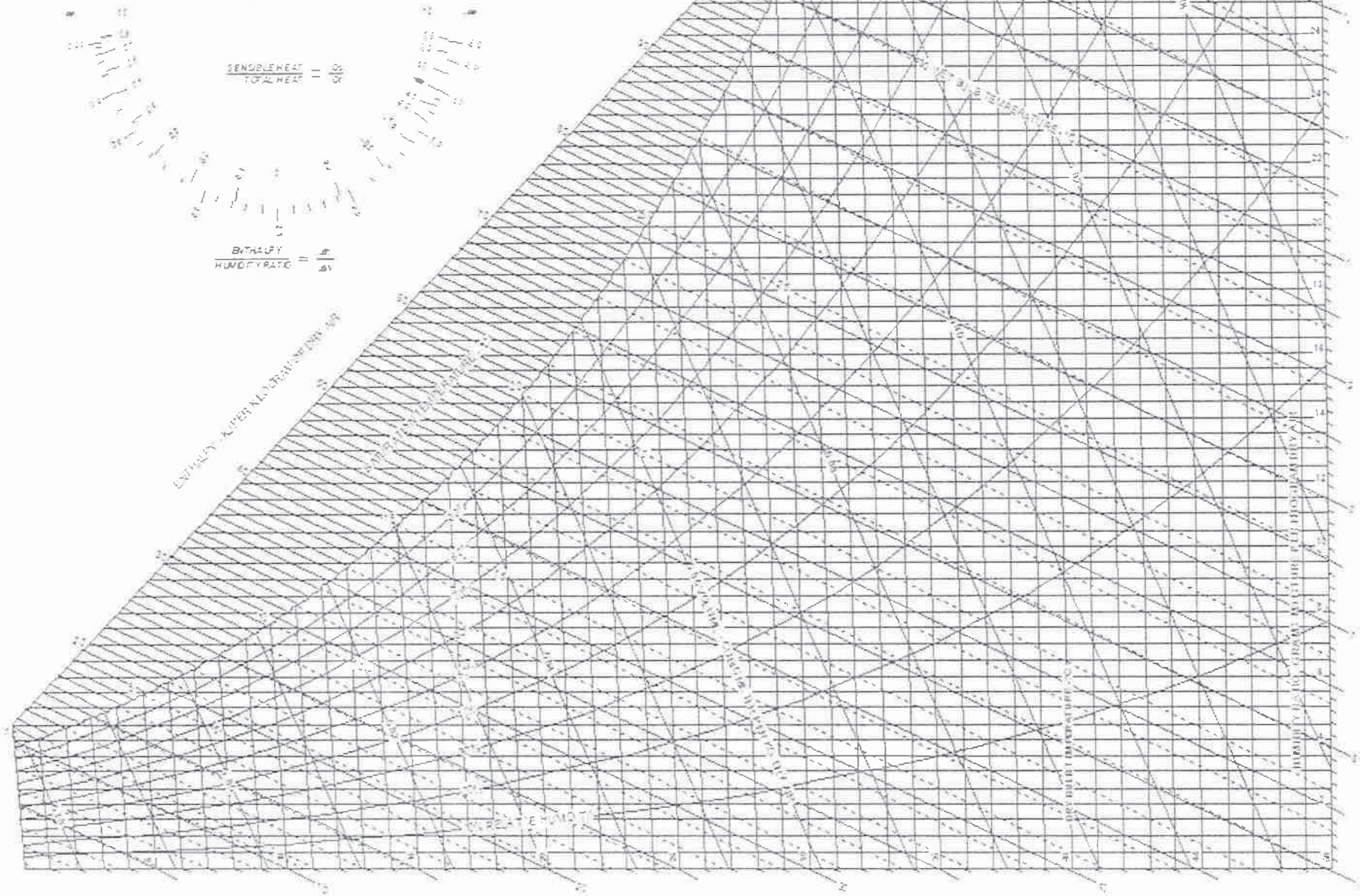
(3) Sketch the floor plan of a residential unit with one bedroom one living room, one kitchen and one washroom. Place the FCU and HRC and draw all the connections (air duct, water pipes, drainage). Show which section of air duct should be insulated.

ASHRAE PSYCHROMETRIC CHART NO.1

NORMAL TEMPERATURE

BAROMETRIC PRESSURE: 101 325 kPa

SEA LEVEL



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Marking Scheme

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7. (1) 10 marks; (2) 4 marks; (3) 3 marks; (4) 3 marks
8. (1) 4 marks; (2) 4 marks; (3) 4 marks; (4) 4 marks; (5) 4 marks
9. (1) 10 marks; (2) 10 marks
10. 20 marks
11. (1) 5 marks; (2) 5 marks; (3) 5 marks; (4) 5 marks
12. (1) 8 marks; (2) 6 marks; (3) 6 marks