30.5 EXCELLENT

ME 0934445: HVAC		الاسم:
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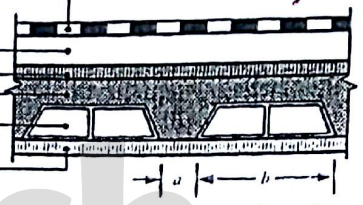
Question 1 [4 points] Consider the following ceiling construction, and calculate its U value if:

a. There is NO insulation.	$R_{total} = R_i + R_o + \Sigma R_{cond}$ $R_{total1} = 0.1 + 0.04 + \frac{0.02}{0.7} + \frac{0.05}{0.95} + \frac{0.06}{1.75}$ $R_{total1} = 0.4376 \frac{m^2 \cdot K}{W}$ $+ \frac{0.18}{0.95} + \frac{0.02}{1.2}$
b. The insulation layer is increased to 10 cm.	$R_1 = R_{total1} + \frac{0.1}{0.03} = 3.771 \rightarrow U_1 = 0.2652 \frac{W}{m^2 \cdot K}$ $R_2 = R_{total2} + \frac{0.1}{0.03} = 3.68 \frac{m^2 \cdot K}{W} \rightarrow U_2 = 0.2714 \frac{W}{m^2 \cdot K}$

$R_{total2} = R_{total1} - \frac{0.18}{0.95} + \frac{0.18}{1.75}$

$= 0.4376 - 0.18 + 0.103 = 0.3551 \frac{m^2 \cdot K}{W}$

k W/m°C	Thickness	Layer	
0.70	0.02 m	①	Asphalt
1.75	0.05 m	②	Concrete
0.03		③	Polystyrene
1.75	0.06 m	④	Concrete
0.95	0.18 m	⑤	Brick
1.2	0.02 m	⑥	Plaster



$U_{total} = 0.2473 \frac{W}{m^2 \cdot K}$

a/b = 1/3

$U_{total} = U_1 \times \frac{2}{3} + U_2 \times \frac{1}{3} = 2.4773 \frac{W}{m^2 \cdot K}$

Question 2 [6points] Consider the following wall construction, calculate its U value, and inner wall surface temperature if the indoor conditions are 23°C and 50% relative humidity and check if condensation will occur:

a. There is NO insulation.	U value	$R_{total} = 0.06 + 0.12 + \Sigma R_{cond}$ $= 0.06 + 0.12 + \frac{0.07}{1.7} + \frac{0.2}{1.75} + \frac{0.07}{1.2} + \frac{0.03}{1.2}$ $= 0.419 \frac{m^2 \cdot K}{W}$
	Inner wall temp?	17°C
	Condensation? Yes or no, why?	No because condensation Tempreture = 12°C
b. The insulation layer is increased to 10 cm.	U value	$R = 0.419 + \frac{0.1}{0.03} = 3.7523 \frac{m^2 \cdot K}{W}$ $U = 0.267 \frac{W}{m^2 \cdot K}$
	Inner wall temp?	22.33°C
	Condensation? Yes or no, why?	No because T condensation is 12°C and this Tempreture is above it

$U = 2.3878 \frac{W}{m^2 \cdot K}$

$Q = U A \Delta T$

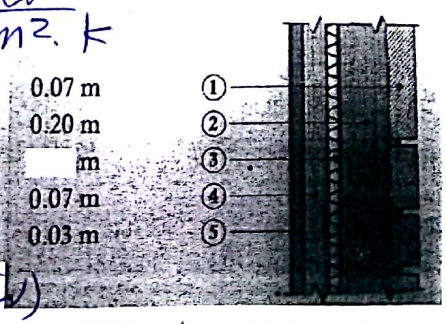
$\frac{Q}{A} = U(23 - 2)$

$= 50.1414$

$50.1414 = \frac{1}{0.12}(23 - T_w)$

$T_w = 17°C$

Stone	0.07 m	①
Concrete	0.20 m	②
Insulation	m	③
Cement Brick	0.07 m	④
Plaster	0.03 m	⑤



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N = 10

outside conditions → ϕ = 30 %, T_{db} = 33°, Twb = 20°

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Question 3 [6 points] During summer, Ten employees work at an open space office building in Amman (100 m^2), they work from 8:00 am till 4:00 pm, indoor conditions [22°C , 50 % RH] calculate:

A	Ventilation volume flow rate [l/s]	$V^\circ = 10 \times 10 = 100$ L/s + 1000 = 1100 L/s
B	Ventilation mass flow rate [kg/s]	$v = 0.88 \frac{m^3}{kg}$ $m^\circ = \frac{V^\circ}{v} = \frac{1.1}{0.88}$ = kg/s × 1.25
C	Total and latent heat gain due Ventilation load	$Q^\circ_{Latent} = 10(45) = 450$ W Q°_{Latent} = 4.375 kW $Q^\circ_{total} = 10(45 + CLF(70))$ $= 10(45A)$ Q°_{total} = 18.125 kW
D	Total heat gain due to occupants at 12:00	$Q^\circ = 10(45 + CLF(70))$ $= 10(45 + 0.7 \times 70)$ = 954 W

$Q^\circ_{sensible}$
$= m^\circ c_p \Delta T$
$= 13.75$ kW

$Q^\circ_{Latent} = Q^\circ_{total} - Q^\circ_{sensible}$

$Q^\circ_{total} = 1.25 \Delta h = 1.25(57.5 - 45) = 18.125$ kW

Question 4, [4 points] Outside air at 35 °C dry-bulb and 70% relative humidity is cooled to 17 °C dry-bulb and 50% relative humidity, if air is flowing at a flow rate of 500 l/s, calculate:

a	The cooling coil capacity	$Q^\circ = m^\circ \Delta h = \frac{0.5}{0.91}(100 - 31.5)$ = 37.64 kW
b	Mass flow rate of chilled water s supplied to the coil at 7°C and return to the chiller at 12°C	$37.64 = m^\circ c_p \Delta T$ $m^\circ = \frac{37.64}{4.186(5)}$ = 1.8 kg/s
c	Amount of condensed water during the operation of one hour of the system	$w_1 = 0.0252 \frac{kg_{H2O}}{kg_{dry\,air}}$ $w_2 = 0.0058$

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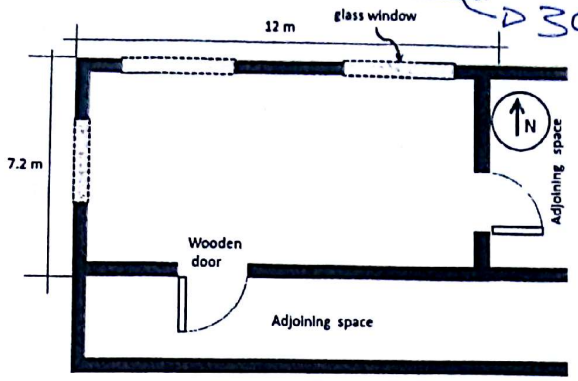
$m^\circ_V = m^\circ \Delta w$
$= 0.55 \times (0.0252 - 0.0058)$
$= 0.0107 \frac{kg_{H2O}}{s}$
$= 38.412 \frac{kg_{H2O}}{hr}$

Question 5, [6 points] An office of (12 * 7.2 * 3 m) located in Irbid where the outside air at 2 °C dry-bulb and 50% relative humidity and inside conditions are (20 °C, 50 % RH), calculate:



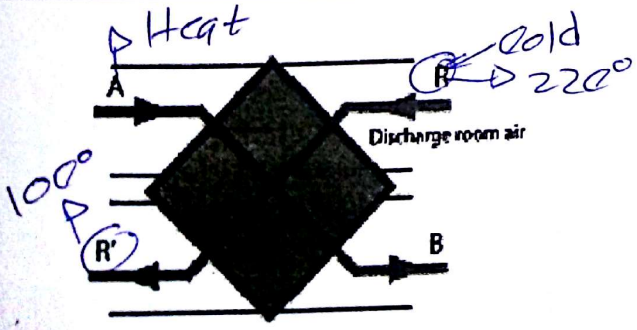
a	Volume and mass flow rates of infiltration [m^3/h] and [kg/s]	$V^\circ = 12 \times 7.2 \times 3 \times 2 = 518.4 \frac{m^3}{h}$ $m^\circ = \frac{V^\circ}{v} = \frac{518.4/3600}{0.78} = 0.185$ kg/s
b	Sensible load due to infiltration	$Q^\circ_{sensible} = m^\circ c_p \Delta T = 3.33$ kW
c	latent load due to infiltration	$Q^\circ_{total} - Q^\circ_s = Q^\circ_{Latent}$ $Q^\circ_{latent} = m^\circ \Delta h - Q^\circ_s$ $= 2.5$ kW

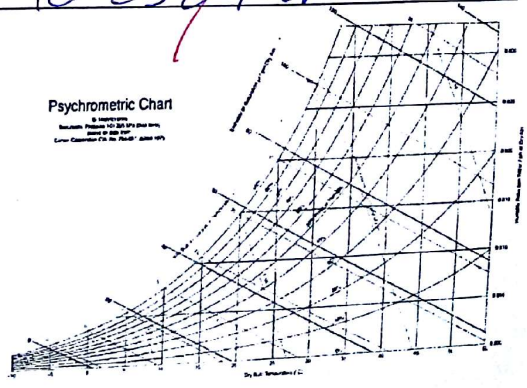
Question 6, [points] The capacity of the heating coil 1000 l/s of outside fresh air at (2°C, 50% RH) is sensibly heated for ventilation purpose, if the inside room conditions are (22°C, 50% RH), calculate the capacity of the heating coil for ventilation purpose?

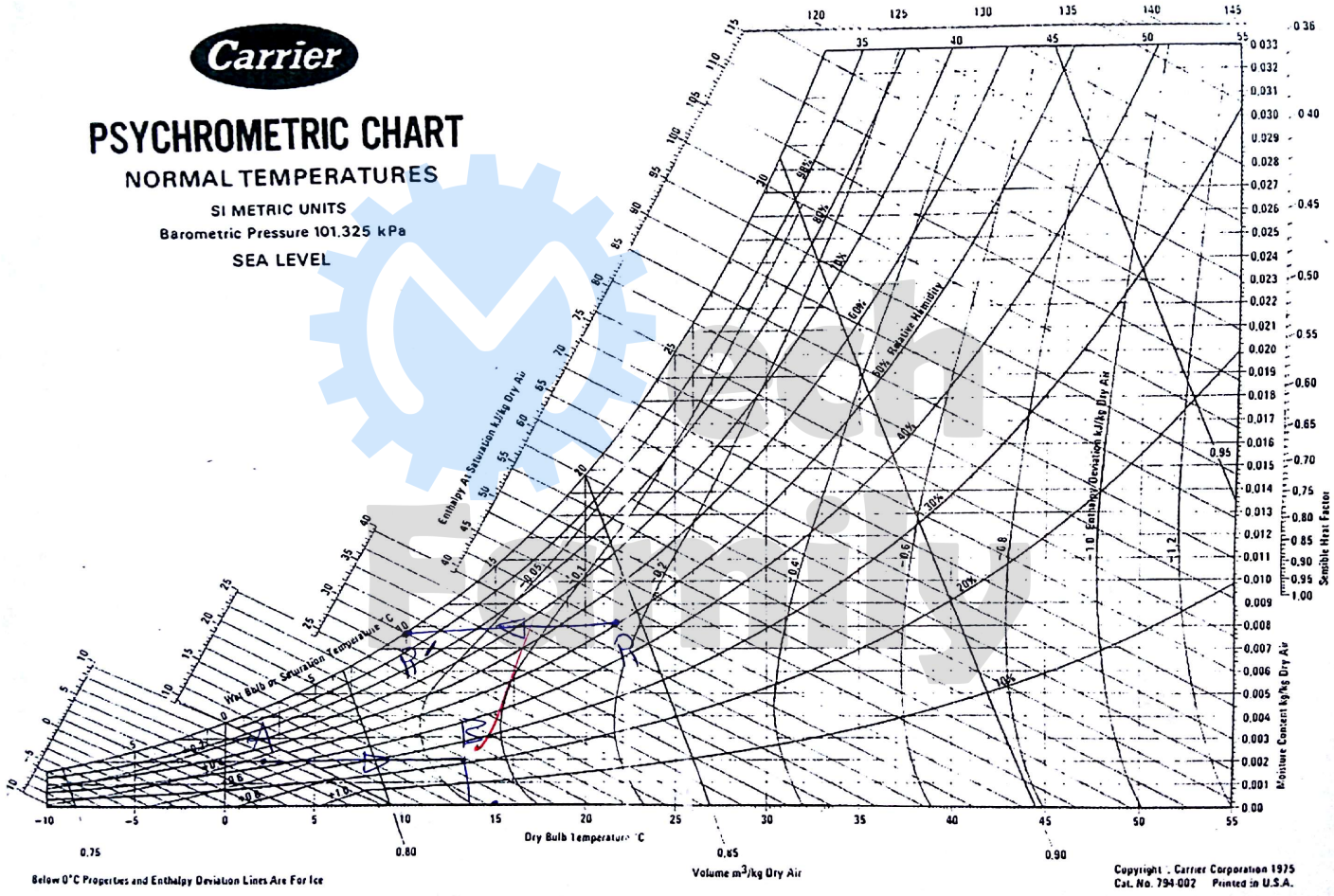
Heating coil kW	$m^\circ = \frac{V^\circ}{v} = \frac{1}{0.78} = 1.282$ kg/s $Q^\circ = m^\circ c_p \Delta T = 1.282 \times 1 \times 20$ $= 25.64$ kW

A plate heat exchanger is used to preheat the fresh air (A) to sate(B) before entering the heating coil by exchange heat from the discharge (exhaust) room (R), if the temperature at(R')is 10°C, and the effectiveness of the heat exchanger is 100%, what is the conditions of state B, and what is the new capacity of the heating coil for the ventilation air? **[sketch the 4 states, and the processes on the psychrometric chart]**

State B	State B = (14°, 20% RH)
Heating coil kW	$Q^\circ = m^\circ c_p \Delta T = 1.282 \times (1)(22 - 14)$ $= 10.256$ kW







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