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Task1:

Use a weather forecast website, and utilize the psychrometric chart and the formula we went through in the class to determine the absoloute humidity, the wet-bulb temperature and the mass of water vapour in the air in ClassRoom A (Aula A) of Piacenza campus in the moment that you are solving this exercise (provide the inputs that you utilized)
Umidità: Relative humidity, Pressione atmosferica: Air total pressure (1 hPa: 0.1 kPa), Temperatura effettiva: temperature to be utilized.

ANSWER:

Il tempo oggi in Piacenza
Martedì, 03 Dicembre 2019

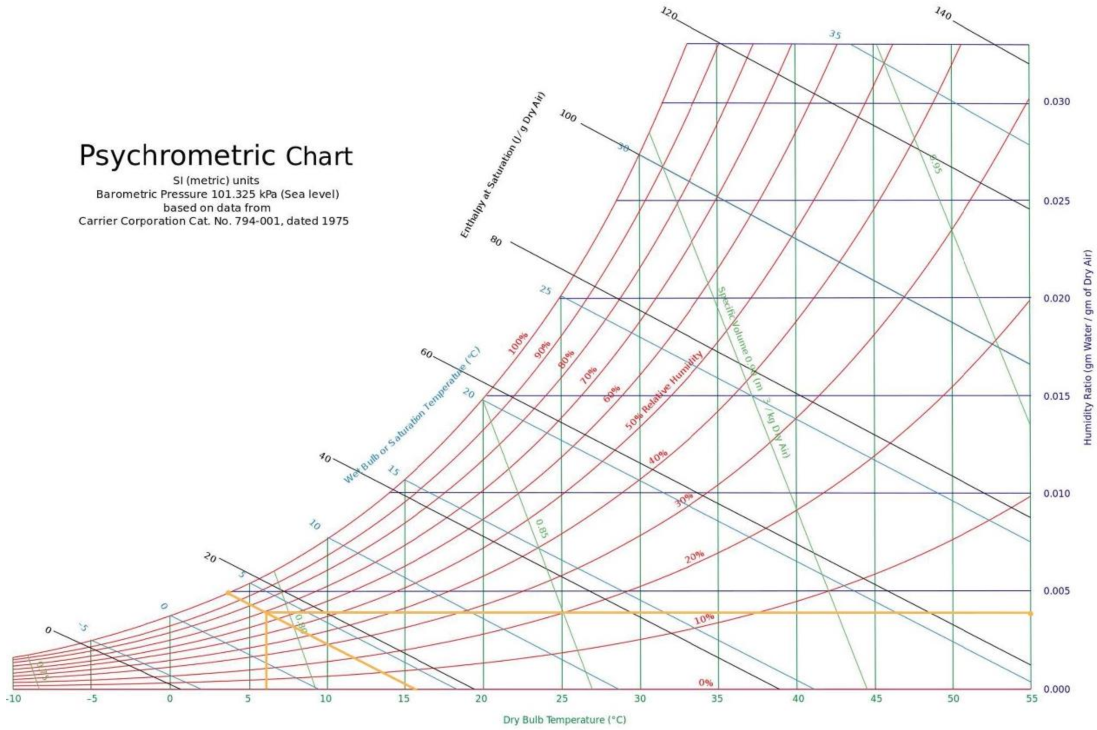
	13:00	14:00	16:00	18:00	20:00	21:00	22:00
	LightCloud	LightCloud	PartlyCloud	LightCloud	Sun	Sun	Sun
Temperatura effettiva	9°C	10°C	8°C	6°C	4°C	2°C	2°C
Temperatura percepita	7°C	10°C	6°C	4°C	2°C	0°C	0°C
Precipitazioni	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Umidità	67 %	65 %	69 %	70 %	75 %	83 %	87 %
Pressione atmosferica	1025 hPa	1025 hPa	1025 hPa	1026 hPa	1027 hPa	1027 hPa	1028 hPa

The time is 18:23 now, we can see form the chart that:

Relative humidity: $\phi = 70\%$

Air total pressure: $P = 1026hPa = 102.6kPa$

Temperature: $T = 6°C$



We can see from above chart that:

(1) *The absolute humidity* $\omega = 0.004 \frac{Kg_{vapour}}{kg_{dryAir}}$

(2) *The wet-bulb temperature* $T_{wb} = 4\ °C$

(3) $\omega = 0.622 \frac{P_v}{P_a} = 0.622 \frac{P_v}{P - P_v} = 0.004 \frac{Kg_{vapour}}{kg_{dryAir}}$; $P = 102.6kPa$

So, $P_v = 0.66kPa$

$m = \frac{PV}{R_{sp.}T}$; $R_{sp.} = \frac{R_{global}}{M_{gas}}$ $\dashrightarrow$ We can find it in Tables $R_v = 0.4615$

$$m_v = \frac{0.66\ \times V_{Aula\ A}}{0.4615\ \times (273 + 6)} = 0.005V_{Aula\ A} = 0.005 \times (15 \times 6 \times 6) = 2.7kg$$

Task 2:

Utilize the same methodology we went through in the class and determine the sensible and latent load corresponding to internal gains, the ventilation, and the infiltration in a house with a *good* construction quality and with the same geometry as that of the example which is located in Brindisi, Italy.

ANSWER:

BRINDISI, Italy WMO#: **163200**

Lat: **40.65N** Long: **17.95E** Elev: **10** StdP: **101.2** Time Zone: **1.00 (EUW)** Period: **86-10** WBAN: **99999**

Annual Heating and Humidification Design Conditions

	Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB		
				99.6%			99%			0.4%		1%				
		99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	
(1)	2	2.9	4.1	-5.1	2.5	7.2	-3.0	3.0	7.4	13.4	10.2	12.4	10.6	3.4	250	(1)

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

	Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB		
			0.4%		1%		2%		0.4%		1%		2%				
			DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(2)	8	7.1	32.8	23.6	31.1	24.3	29.9	24.3	27.2	29.7	26.3	29.0	25.6	28.3	4.2	180	(2)

	Dehumidification DP/MCDB and HR									Enthalpy/MCDB						Hours 8 to 4 & 12.8/20.6	
	0.4%			1%			2%			0.4%		1%		2%			
	DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB		
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(3)	26.3	21.8	29.2	25.4	20.7	28.5	24.7	19.7	27.9	86.0	30.1	82.2	29.1	78.5	28.3	1236	(3)

Extreme Annual Design Conditions

	Extreme Annual WS			Extreme Max WB	Extreme Annual DB				n-Year Return Period Values of Extreme DB								
					Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years		
	1%	2.5%	5%		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(4)	11.3	9.9	8.7	31.4	0.4	37.3	1.4	3.0	-0.6	39.4	-1.4	41.1	-2.2	42.8	-3.2	44.9	(4)

$\Delta T_{cooling} = 31.1 - 24 = 7.1\,°C$

$\Delta T_{\text{heating}} = 20 - 4.1 = 15.9\,°C$

$H_{building} = 2.5m$

$A_{roof} = 200m^2$

$A_{wall} = 144m^2$

Two occupants

One bedroom

Internal gains:

$$\dot{Q}_{ig_{sensible}} = 136 + 2.2 \times A_{cf} + 22\, N_{oc} = 136 + 2.2 \times 200 + 22 \times 2 = 620\, W$$

$$\dot{Q}_{ig_{latent}} = 20 + 0.22 \times A_{cf} + 12\, N_{oc} = 20 + 0.22 \times 200 + 12 \times 2 = 88\, W$$

Infiltration:

Table 3 Unit Leakage Areas

Construction	Description	A_{ul}, cm²/m²
Tight	Construction supervised by air-sealing specialist	0.7
Good	Carefully sealed construction by knowledgeable builder	1.4
Average	Typical current production housing	2.8
Leaky	Typical pre-1970 houses	5.6
Very leaky	Old houses in original condition	10.4

$A_{es} = A_{wall} + A_{roof}$

$= 200 + 144 = 344\, m^2$

$A_L = A_{es} \times A_{ul}$

$= 344 \times 1.4 = 481.6\, cm^2$

Table 5 Typical IDF Values, L/(s·cm²)

H, m	Heating Design Temperature, °C					Cooling Design Temperature, °C			
	−40	−30	−20	−10	0	10	30	35	40
2.5	0.10	0.095	0.086	0.077	0.069	0.060	0.031	0.035	0.040
3	0.11	0.10	0.093	0.083	0.072	0.061	0.032	0.038	0.043
4	0.14	0.12	0.11	0.093	0.079	0.065	0.034	0.042	0.049
5	0.16	0.14	0.12	0.10	0.086	0.069	0.036	0.046	0.055
6	0.18	0.16	0.14	0.11	0.093	0.072	0.039	0.050	0.061
7	0.20	0.17	0.15	0.12	0.10	0.075	0.041	0.051	0.068
8	0.22	0.19	0.16	0.14	0.11	0.079	0.043	0.058	0.074

$$IDF_{\text{heating}} = 0.065 \frac{L}{s.cm^2}$$

$$IDF_{cooling} = 0.032 \frac{L}{s.cm^2}$$

$$Q_{infiltration_{\text{heating}}} = A_L \times IDF_{\text{heating}} = 481.6 \times 0.065 = 31.30 \frac{L}{s}$$

$$Q_{infiltration_{cooling}} = A_L \times IDF_{cooling} = 481.6 \times 0.032 = 15.41 \frac{L}{s}$$

Ventilation:

$$Q_v = 0.05\, A_{cf} + 3.5\,(N_{br} + 1) = 0.05 \times 200 + 3.5 \times 2 = 17 \frac{L}{s}$$

$$Q_{inf-ventilation_{\text{heating}}} = Q_{infiltration_{\text{heating}}} + Q_v = 31.30 + 17 = 48.30 \frac{L}{s}$$

$$Q_{inf-ventilation_{cooling}} = Q_{infiltration_{cooling}} + Q_v = 15.41 + 17 = 32.41 \frac{L}{s}$$

$$C_{sensible} = 1.23\,,\ C_{latent} = 3010$$

$$\dot{Q}_{inf-ventilation_{cooling_{sensible}}} = C_{sensible} Q_{inf-ventilation_{cooling}} \Delta T_{Cooling} = 1.23 \times 32.41 \times 7.1 = 283.04 W$$

$$\dot{Q}_{inf-ventilation_{\text{heatingg}_{sensible}}} = C_{sensible} Q_{infiltration_{\text{heating}}} \Delta T_{\text{heating}} = 1.23 \times 48.30 \times 15.9 = 944.60\, W$$

$$\Delta\omega = \omega_{out} - \omega_{in} = 0.0132 - 0.0093 = 0.0039 \frac{kg_{water}}{kg_{DryAir}}$$

$$\dot{Q}_{inf-ventilation_{cooling_{latent}}} = C_{latent} Q_{inf-ventilation_{cooling}} \Delta\omega_{Cooling} = 3010 \times 32.41 \times 0.0039 = 380.46\, W$$