TASK 1

Use a weather forecast website, and utilize the psychrometric chart and the formula we went through in the class to determine the absolute humidity, the wet-bulb temperature and the mass of water vapor 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)

ANSWER

At the time solving this exercise,

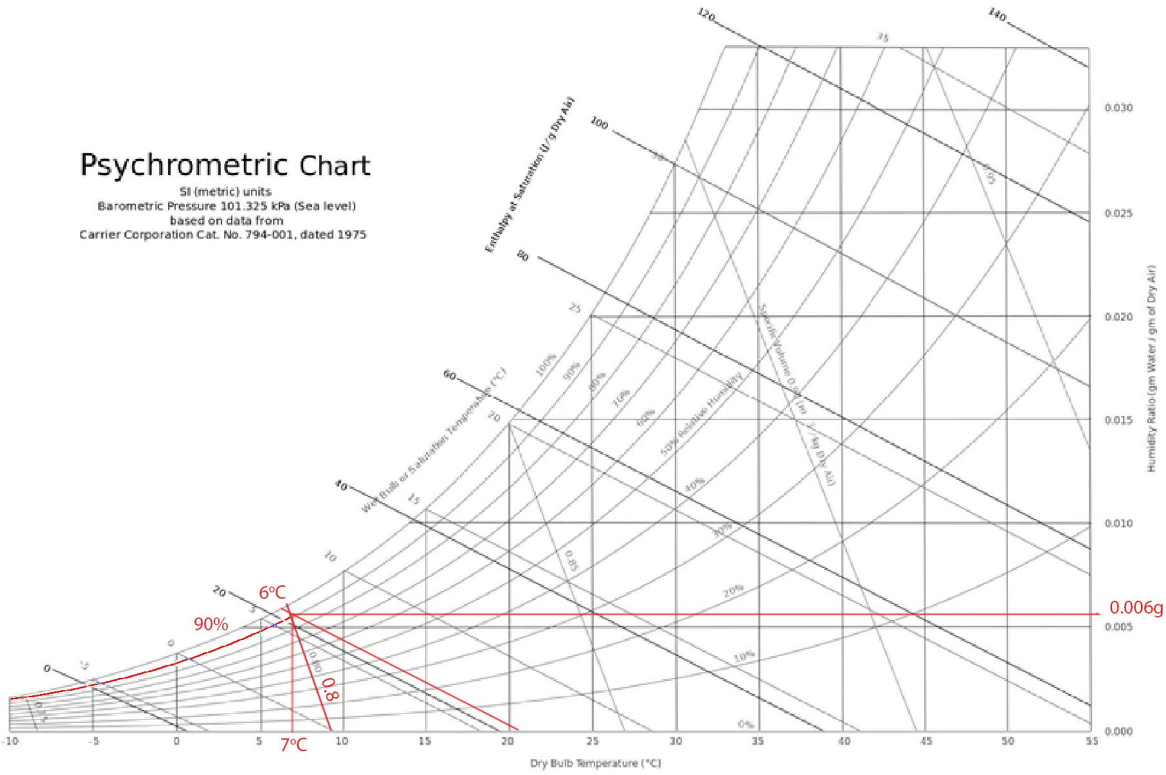
Temperature	$T = 7°C$
Relative Humidity	$\phi = 90\%$
Air Total Pressure	$P = 1019hPa = 101.9kPa$

Consider the dimensions of Aula A as follow:

$$V = d \times w \times h = 18 \times 6 \times 5 = 540m^3$$

Using Psychrometric Chart,

Absolute Humidity	$\omega = 0.006\frac{kg_{water}}{kg_{dryAir}}$
Wet-bulb Temperature	$T_{wetbulb} = 6°C$
Specific volume	$0.8m^3/kg_{dryair}$
Enthalpy	$h = 21\frac{kJ}{kg_{dryAir}}$



Using Formula,

We have $\phi = \frac{m_v}{m_g} = \frac{P_v}{P_g}$

The saturation pressure of water at 7°C $\quad P_g = 1.002$ kPa (using Tetens' formula)

Partial pressure of vapor $\quad P_v = P_g \times \phi = 1.002 \times 90\% = 0.902\ kPa$

Partial pressure of dry air $\quad P_a = P - P_v = 101.9 - 0.9 = 101\ kPa$

Absolute Humidity $\quad \omega = 0.622 \frac{P_v}{P_a} = 0.622 \frac{0.9}{101} = 0.0055 \frac{kg_{water}}{kg_{dryAir}}$

Mass of water vapor $\quad m_v = \frac{P_v V}{R_v T} = \frac{0.9 \times 540}{0.4615 \times (273+7)} = 3.761 kg\ of\ water$

Enthalpy of dry air $\quad h_a = 1.005 \times T = 1.005 \times 7 = 7.035 \frac{kJ}{kg_{dryAir}}$

Enthalpy of vapor $\quad h_v = 2501.3 + 1.82 \times T = 2501.3 + 1.82 \times 7 = 2514.04 \frac{kJ}{kg_{dryAir}}$

Total enthalpy

$$h_{total} = h_a + h_v \times \omega = 7.035 + 2514.04 \times 0.0055 = 20.86 \frac{kJ}{kg_{dryAir}}$$

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 (Height of 2.5 m, conditioned floor area of 200 m^2 and wall area is 144 m^2, two occupants and one bed room) located in Brindisi, Italy

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)

ANSWER

Internal Gain

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

$\dot{Q}_{ig_{latent}} = 20 + 0.22 * A_{cf} + 12\ N_{oc} = 20 + 0.22 * 200 + 12 * 2 = 88\ WDR = 11.9\ °C$

Infiltration and Ventilation

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

Good Construction quality → A_{ul}=1.4cm²/m²

Total leakage Area $A_L = A_{es} \times A_{ul} = (200 + 144) \times 1.4 = 481.6cm^2$

From Brindisi Weather Design Condition and table 5, typical IDF values,

Heating design temperature 4.1°C → $IDF_{heating} = 0.065 \frac{L}{s.cm^2}$

Cooling design temperature 31.1°C → $IDF_{cooling}\ = 0.032 \frac{L}{s.cm^2}$

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

$\dot{V}_{infiltration_{heating}} = A_L \times IDF_{heating} = \ \ 486.1 \times 0.065 = 31.60 \frac{L}{s}$

$$\dot{V}_{infiltration_{cooling}} = A_L \times IDF_{cooling} = \ 486.1 \times 0.032 = 15.56\frac{L}{s}$$

$$\dot{V}_{ventilation} = 0.05\, A_{cf} + 3.5\,(N_{br} + 1) = 0.05 \times 200 + \ 3.5 \times (1 + 1) \ = \ 17\ \frac{L}{S}$$

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

$$\dot{Q}_{inf-vent_{heating_{sensible}}} = C_{sensible}\dot{V}_{inf-vent}\Delta T_{heating} = 1.23 \times (31.6 + 17) \times (20 - 4.1) = 950.5\ W$$

$$\dot{Q}_{inf-vent_{cooling_{sensible}}} = C_{sensible}\dot{V}_{inf-vent}\Delta T_{cooling} = 1.23 \times (15.56 + 17) \times (31.1 - 24) = 284.3\ W$$

Using Psychrometric Chart, at 50% relative humidity,

At 31.1°C, $\omega_{outside} = 0.0132\,\frac{kg_{water}}{kg_{dryAir}}$

At 24°C, $\omega_{inside} = 0.0093\,\frac{kg_{water}}{kg_{dryAir}}$

→ $\Delta\omega_{cooling} = 0.0132 - 0.0093 = 0.0039$

$$\dot{Q}_{inf-vent_{cooling_{lantent}}} = C_{lantent}\dot{V}_{inf-vent}\Delta\omega_{cooling} = 3010 \times (31.6 + 17) \times 0.0039 = 570.5\ W$$