Assignment 9

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Question 1

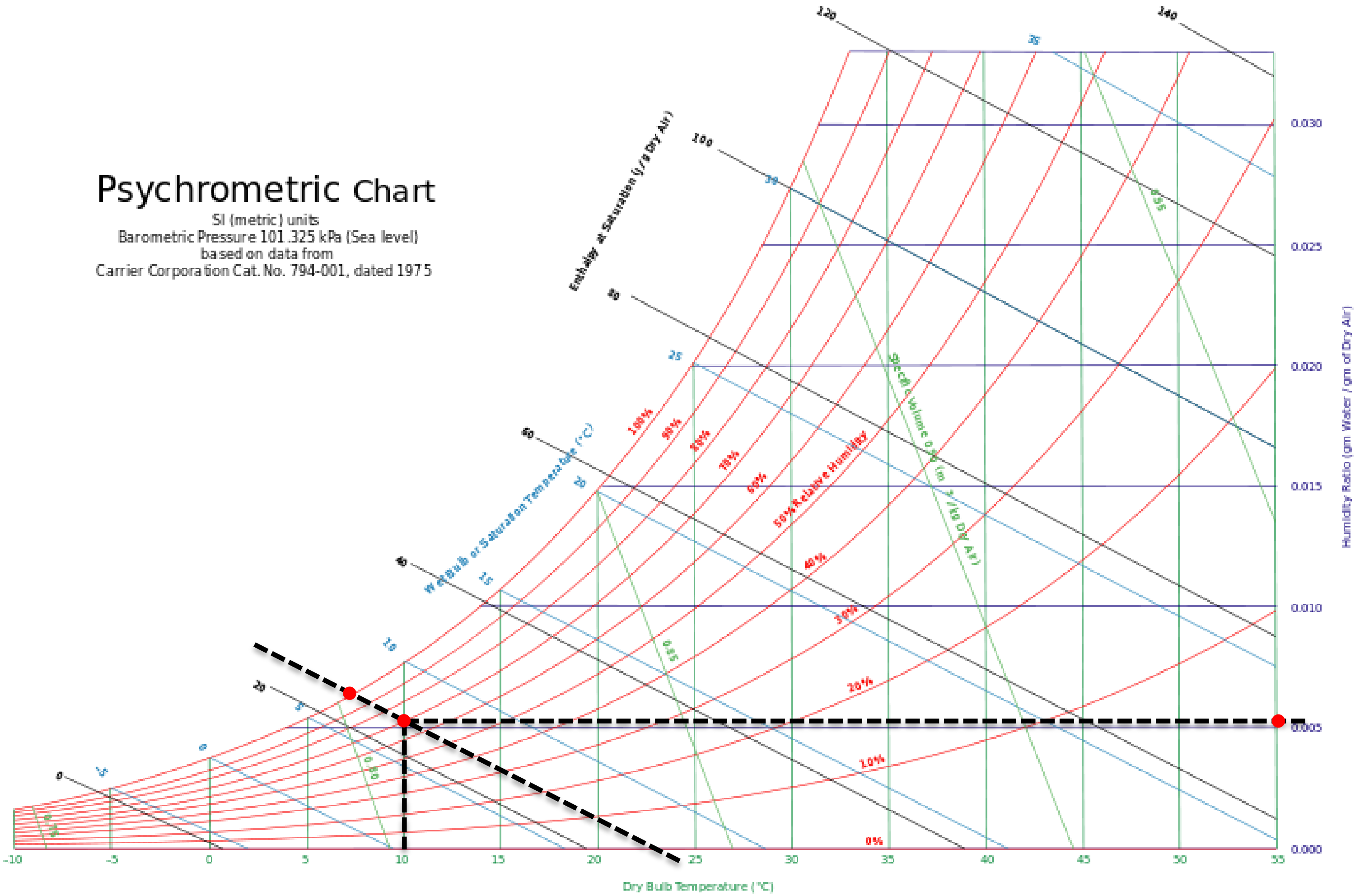
Use a weather forecast website, and utilize the psychometric chart and the formula we went through in the class to determine the absolute humidity, the wet-bulb temperature and the mass of water vapor in the air in Classroom A (Aula A) of Piacenza campus in the moment that you are solving

Umidità: Relative humidity, Pressione atmospheric: Air total pressure (1 hPa: 0.1 kPa), Temperature effettiva: temperature to be utilized.

The weather today in Piacenza
Tuesday, 03 December 2019

	1:00 pm	14:00	4:00 pm	18:00	8:00 pm	21:00	22:00
	LightCloud	LightCloud	PartlyCloud	LightCloud	Sun	Sun	Sun
Effective temperature	9 ° C	10 ° C	8 ° C	6 ° C	4 ° C	2 ° C	2 ° C
Perceived temperature	7 ° C	10 ° C	6 ° C	4 ° C	2 ° C	0 ° C	0 ° C
Rainfall	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Humidity	67 %	65 %	69 %	70 %	75 %	83 %	87 %
Atmospheric pressure	1025 hPa	1025 hPa	1025 hPa	1026 hPa	1027 hPa	1027 hPa	1028 hPa
Wind intensity	15 km / h	14 km / h	9 km / h	9 km / h	7 km / h	8 km / h	8 km / h
Wind direction	←	←	←	←	↖	↖	↖

The hour at the moment is 14:30. According to the weather forecast shown above we know that there is no chances of rainfall, effective temperature 9˚C (T= 282.15 Kalvin), the humidity is 65% (relative humidity Φ= 65%), and the atmospheric pressure 1025 hPa (total air pressure P= 102.5 kPa)



Utilize the psychometric chart, we can see, the humidity ratio, i.e., the absolute humidity ω=0.0052

The web-bulb temperature T_{wb} = 10˚C

Therefore $\omega = \frac{0.622\,Pv}{Pa} = \frac{0.622\,Pv}{P-Pv} = 0.0052$, introduce P = 102.5 KPa into this equation, and solve it. $\frac{0.622\,Pv}{102.5-pv} = 0.0052$

P_V = 0.8498 KPa

Autem, $\Phi = \frac{mv}{mg}$ = 70% ……. (1)

For any ideal gas, m = $\frac{Pv}{RSPT}$, during the class we were told that for water vapor, R_{sp}= 0.4615

Introduce the pressure of water vapor P_V = 0.8498 KPa, and define the volume of Aula A is

V: $m_v = \frac{0.8498V}{0.4615*282.15}$ = 130.212225 V

Subordinate this value to equation number (1)

Calculate the maximum water vapor $m_g = \frac{mv}{70\%} = 9.34 \times 10^{-3}V$

Question 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

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)

Height= 2.5 m; Floor area= 200 m^2; Wall area= 144 m^2

Internal Gains:

Sensible cooling load from internal gains,

$q_{ig,sensible} = 136+2.2A_{cf}+22N_{oc} = 136+2.2*200+22*2 = 620W$

Latent cooling load from internal gains,

$q_{ig,latent} = 20+0.22A_{cf}+12N_{oc} = 20+0.22*200+12*2 = 88W$

Infiltration:

Unit leakage area A_{ul}= 1.4 cm^2/m^2

Exposed surface A_L= A(wall)+ A(roof)= 200+144= 344m^2

So, $A_L = A_{es}*A_{ul}$= 344*1.4= 481.6 cm^2

Define the cooling temperature $T_{cooling}$ = 24°C, and heating temperature $T_{heating}$ = 20°C in Brindisi,

Δ T cooling = 31.1– 24 = 7.1°C = 7.1 k

Δ T heating = 20 °C – (- 4.1°C) = 24.1 °C = 24.1 k

DR = 7.1 °C = 7.1 k

Given: IDF (heating) = 0.073 $\frac{L}{s*cm2}$

IDF (cooling) = 0.033$\frac{L}{s*cm2}$

Calculate infiltration airflow rate,

$Q_{I, heating} = A_L * IDF_{heating} = 481.6 * 0.073 = 35.157 \frac{L}{s}$

$Q_{i,cooling} = A_L * IDF_{cooling} = 481.6 * 0.033 = 15.893 \frac{L}{s}$

The required minimum whole building ventilation rate is

$Qv= 0.05A_{cf} + 3.5 (N_{br} + 1) = 0.05 * 200 + 3.5 * (1+1) = 17 \frac{L}{s}$

Thus,

$Q_{i\text{-}v, heating} = Q_{I, heating} + Q_v = 35.157 + 17 = 52.157 \frac{L}{s}$

$Q_{i\text{-}v, cooling} = Q_{I, cooling} + Q_v = 15.893 + 17 = 32.893\frac{L}{s}$

Given that $C_{sensible}$ = 1.23, C_{talent} = 3010, Δw cooling = 0.0039

$\dot{q}_{\text{inf-ventilation (cooling sensible)}} = C_{sensible}\, Q_{i\text{-}v,cooling}\, \Delta T cooling = 1.23 * 32.893 * 7.1 = 287.25$ W

$\dot{q}_{\text{inf-ventilation (cooling talent)}} = C_{talent}\, Q_{i\text{-}v,cooling}\, \Delta w cooling = 3010 * 32.893 * 0.0039 = 386.13$ W

$\dot{q}_{\text{inf-ventilation (heating sensible)}} = C_{sensible}\, Q_{i\text{-}v,cooling}\, \Delta T heating = 1.23 * 52.157 * 24.1 = 1546.09$W