$Q_{ROOM} = 72000 \frac{Btu}{hr}$

$T_2 = ?$ $\qquad$ $T_3 = 75F$

$\phi_2 = 100\%$ $\qquad$ $\phi_3 = 50\%$

se $T_2 = 55F$ $\qquad$ $h_3 = 28\ Btu/lb$

$h_2 = 23.21 \ Btu/lb$ $\qquad$ $v_3 = 13.68$

$v_2 = 13, \ ft^3/lb$ $\qquad$ $w = .0092 \frac{lb}{lb}$

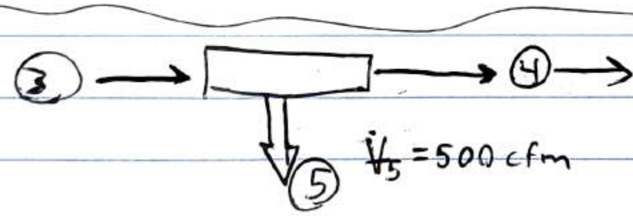
$w_2 = w_3$

$\dot{m} = \frac{\dot{Q}}{\Delta h}$ $\quad$ $\Delta h \rightarrow (h_3 - h_2)$

$\dot{m} = \frac{72000 \frac{Btu}{hr}}{(28.1 - 23.21)\frac{Btu}{lb}}$

$\dot{m} = 14723.9 \frac{lb}{hr} \Rightarrow \dot{m} = 245.4 \frac{lb}{min}$

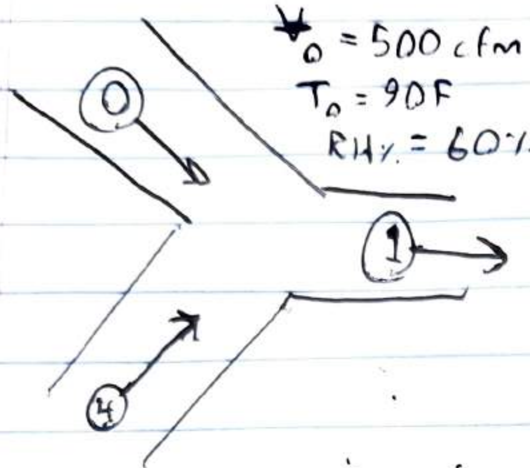
$\dot{m} * v_2 = 3190.2\ cfm$



$\dot{V}_5 = 500\ cfm$

$\dot{V}_4 = \dot{V}_3 - \dot{V}_5 = 2690.2\ cfm$

State 5 is going outdoors so values are equal to State 0.



$\dot{V}_0 = 500$ cfm
$T_0 = 90F$
$RH\% = 60\%$

$\dot{m}_a = \frac{\dot{V}}{v}$

$\dot{m}_0 = 34.97$ kg/min

$\dot{m}_4 = 196.65$ kg/min

$\dot{m}_0 + \dot{m}_4 - \dot{m}_1 = 0$

$\dot{m}_1 = 231.62$

$h_1 = \frac{\dot{m}_0 h_0 + \dot{m}_4 h_4}{\dot{m}_1} \Rightarrow h_1 = 30.07 \frac{Btu}{lb}$

$w_1 = \frac{\dot{m}_1 w_1 + \dot{m}_2 w_2}{\dot{m}_3} \Rightarrow w_1 = 0.011$

(0)

$T_0 = 90F$

$\phi_0 = 60\%$

$\omega_0 = .0183 \frac{lb}{lb}$

$v_0 = 14.3 \frac{ft^3}{lb}$

$h_0 = 41.74 \frac{Btu}{lb}$

(1)

$T_1 = 77F$

$\omega_1 = 0.011 \frac{lb}{lb}$

$v_1 = 13.75$

$h_1 = 30.07 \frac{Btu}{lb}$

(1')

SAME

$T_1' = 55F$

$\phi = 100$

(2)

$T_2 = 55F$

$\phi_2 = 100\%$

$h_2 = 23.21 \frac{Btu}{lb}$

$v_2 = 13 \frac{ft^3}{lb}$

$\omega_2 = \omega_3$

(3)

$T_3 = 75F$

$\phi_3 = 50\%$

$h_3 = 28 \frac{Btu}{lb}$

$v_3 = 13.63 \frac{ft^3}{lb}$

$\omega_3 = .0092 \frac{lb}{lb}$

(4)

$T_4 = 75F$

$\phi_4 = \phi_3$

$h_4 = h_3$

$v_4 = v_3$

$\omega_4 = \omega_3$

But

$\dot{V}_4 = 2690.2$

(5)

SAME

As State 0

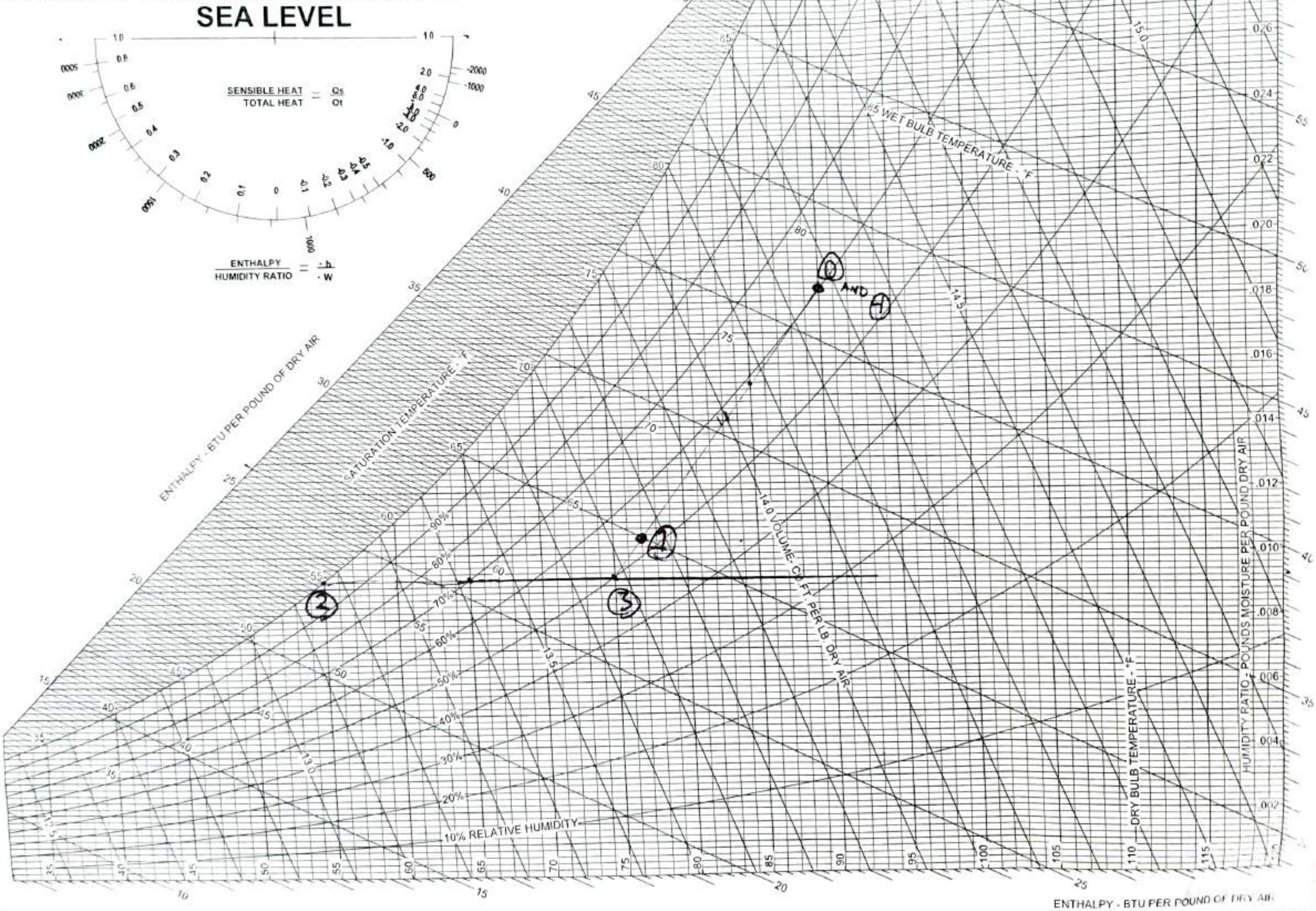
ASHRAE PSYCHROMETRIC CHART NO.1

NORMAL TEMPERATURE

BAROMETRIC PRESSURE: 29.921 INCHES OF MERCURY

Copyright 1992

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.



Handwriting this would have caused a time crunch on our end so we typed

Resources
Thermodynamics, An Engineering Approach (9th Edition)
*This includes tables

MET350 Notes by Colby Watts and Gabriel Cabello Torres

MET350 Homeworks, Modules, and Examples (Provided by Professor Ayala)

ASHRAE Psychrometric Chart

Online Virtual Psychrometric Chart: https://www.psych-chart.com/
**We did not blindly trust the site and confirmed with the physical chart first*

Approach
Here's what we know about the test.
Tdb = 75F, and RH= 50%
State 5 has a 500CFM value
State 0 has an entrance value of 500CFM
Outdoor Air conditions are 90F and RH = 60% (this affects State 0)
The Cooling and Dehumidifying Unit is IDEAL which means RH is 100% at State 1'
Fan is ideal so the only thing changing about State 1' is the CFM.

We assumed the following. State 3, which is leaving the conditioned space, has the same values as the conditioned space. Ergo, T3 = 75F, RH3 = 50%, and all the psychrometric chart values along with it.

Initially, we assumed that the easiest starting point was to treat State 2 and 3 as its own simple heating problem. Why? Because we had the values for State 3 leaving the Conditioned Space (we'll call this CS from now on). So we set out to treat Q_room as the Q_in of the problem. However, we ran into two issues. We only have the ratio of humidity sharing values with 2 and 3 (which is obtained by 3).

In order to troubleshoot this, we assumed that State 1' left the Cooling and Dehumidifier at an RH of 100% since it is ideal. The fan would not affect the air-state condition since it is also ideal. **However**, we are aware that the fan would **increase the mass flow rate and volume flow rate** because it's still a fan. It would not go without some sort of effect.

We drew a line to Relative Humidity = 100% from the T_db = 75F and RH = 60% on the Psychrometry Chart. We estimated that the number was T2 = 55F because of the simple process heat path having a constant humidity ratio of .0092 lb/lb.

We were met with problems calculating the mass flow rate since the mass flow rate was an unreal number too high for this theoretical scenario. We **know** it's not apt but we tread on anyway

We plugged and chugged for the rest..

350 Test 3 Colby Watts & Gabriel Torres

Purpose ①

- Determine the quantity of the air supplied to the space.
- The state of the air at each of the points shown in drawing (Provide the dry bulb temperature and humidity ratio of each state)
- Draw all processes in the psychrometric chart
- The required capacity of the cooling and dehumidifying unit
- The amount of liquid water drained in the cooling and dehumidifying.
- Temp in conditioned space is dry bulb temperature

Purpose ②

Must provide:

- The operating pressure of the evaporator and the condenser.
- The state of the refrigerant after each of the elements of the vapor-compression refrigeration cycle (Provide pressure, temperature, enthalpy, and quality of each state)
- The P-v and T-s diagrams
- The required refrigerant mass flow rate
- The power required by the compressor in HP
- The waste heat rate

Purpose ③

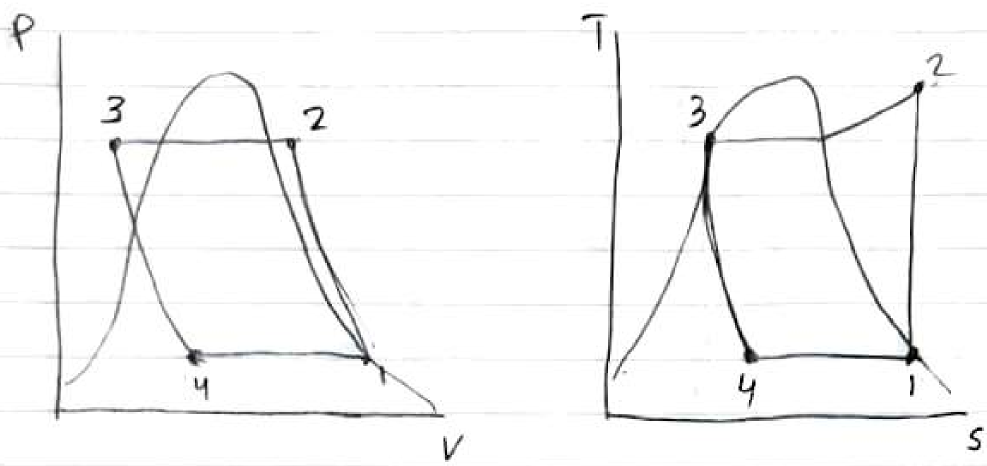
- To judge if idea is feasible, provide:
- The volume flow rate of outside air into the cooling tower
- The mass flow rate of the required makeup water.

Sources

- Thermodynamics: An engineering approach
- Conversion calculators
- Professor Ayala example solutions on Canvas

evap exit = 2.7°C   Condenser exit = 6.3°C   Compressor $\eta = 80\%$

P-V & T-S Diagrams



P_2 @ 9.7°C = 410.83 kPa $P_3 = P_2$

P_1 @ 7°C = 375.055 kPa $h_{g_2} = 256.40$ kJ/kg $P_3 = 410.83$ kPa

$T_1 = 7°C\ (2.3°C)$ $T_2 = T_1 + 2.3°C$ $h_{f3} = 64.97$

$h_{g_1} = 254.52$ kJ/kg $T_2 = 9.7°C$

$T_4 = 6.3°C$

$P_4 = 366.07$

$h_{fg_4} = 193.77$ kJ/kg

$h_{f_4} = 60.34$ kJ/kg

$X_4 = 0$

$X_1 = 1$ (sat)

$$h_2 = h_1 + \frac{h_{g_2} - h_1}{\eta}$$

$$h_2 = 254.52 + \frac{256.03\ \text{kJ/kg} - 254.52\ \text{kJ/kg}}{0.80}$$

$X_1 = 0$ $X_3 = 0$

$$COP = \frac{h_1 - h_4}{h_2 - h_1} = \frac{254.52\ \text{kJ/kg} - 193.77\ \text{kJ/kg}}{256.40\ \text{kJ/kg} - 254.52\ \text{kJ/kg}}$$

$COP = 32.3$

$$\dot{m} = \frac{Q_{in}}{h_1 - h_4} =$$

$W_{comp} = \dot{m}(h_2 - h_1)$

Heat rejected $= \dot{m}(h_2 - h_3)$