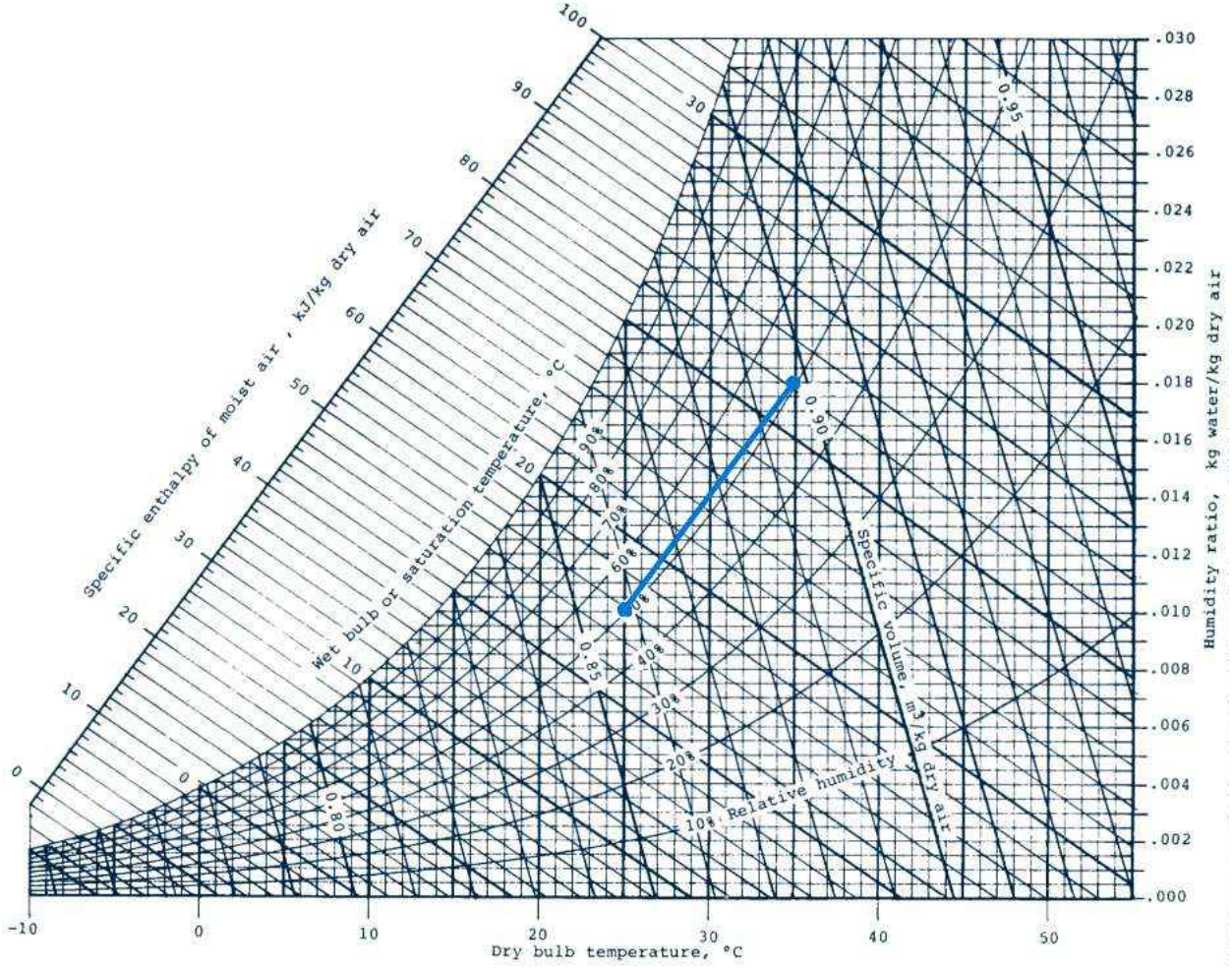
60 $h_{fg} = 2450$ kJ/kg

moisture per person = 0.25 kg/person

people = 4

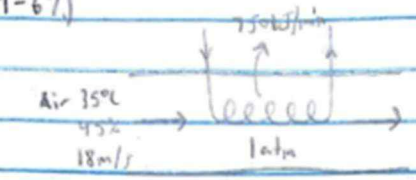
$m_{vapor} = m \cdot 4 = 0.25 \cdot 4 = 1$ kg/day

$Q = m_{vapor} \cdot h_{fg} = 1 \cdot 2450 = 2450$ kJ/day



Cameron Sutton and Shawn Newnam HW 3.5

14-67)



* See next page for psychometric chart

Given: $D = 30\,cm = 0.3\,m$

1 atm

$T_1 = 35°C$

$\phi = 45°C$

$V = 18\,m/s$

$\dot{Q}_{out} = 750\,kJ/min$

From psychometric chart:

$h_1 = 76.5\,kJ/kg\,dry\,air$

$\omega_2 = 0.016\,kg_{wv}/kg_{dry\,air}$

$\omega_2 = \omega_1$

$\dot{m}_{a1} = \rho V A$ $\quad \rho = \frac{1}{v} = v = 0.895\,m^3/kg\,dry\,air$

$\dot{m}_{a1} = \left(\frac{1}{0.895}\right)(18)(0.0707)$ $\quad A = \pi r^2 = \pi(0.15)^2 = 0.0707\,m^2$

$\dot{m}_{a1} = 1.42\,kg_{dry\,air}/s$

$\dot{m}_{a2} = \dot{m}_{a1}$

$\dot{Q}_{in} + \dot{W}_{in} + \sum \dot{m}_i h = \dot{Q}_{out} + \dot{W}_{out} + \sum \dot{m}_o h$

$\dot{m}_1 h_1 = \dot{Q}_{out} + \dot{m}_2 h_2$

$\left(1.42\,\frac{kg_{dry\,air}}{s}\right)\left(76.5\,\frac{kJ}{kg_{dry\,air}}\right) = \left(750\,\frac{kJ}{min}\right)\left(\frac{1\,min}{60\,s}\right) + \left(1.42\,\frac{kg_{dry\,air}}{s}\right)(h_2)$

$108.63\,kJ/s = 12.5\,kJ/s + h_2\left(1.42\,\frac{kg_{dry\,air}}{s}\right)$

$h_2 = 67.7\,kJ/kg_{dry\,air}$

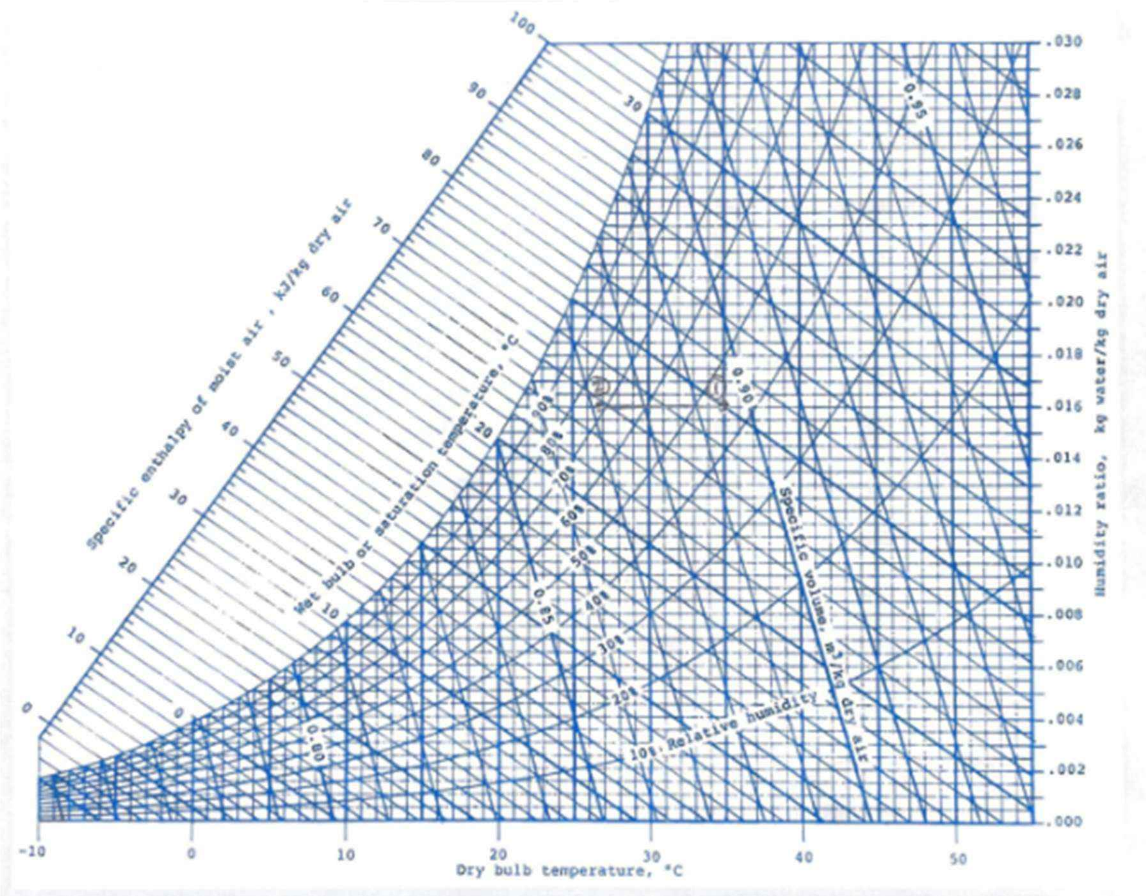
a.) $T_2 = 26.5°C$

b.) $\phi = 72\%$

c.) $\dot{m}_2 = \rho V A$

$1.42 = \left(\frac{1}{0.871}\right) V (0.0707)$

$V_2 = 17.49\,m/s$


Specific enthalpy of moist air, kJ/kg dry air
Wet bulb or saturation temperature, °C
Humidity ratio, kg water/kg dry air
Specific volume, m3/kg dry air
Relative humidity
Dry bulb temperature, °C

7 $T_1 = 90°F$ $\phi = 90\%$ $h_1 = 52.22$ Btu/lbm $\omega_1 = 0.0278$ lb/lb

$T_2 = 50°F$ $\phi = 100\%$ $h_2 = 20.20$ Btu/lbm $\omega_2 = 0.0076$ lb/lb

$h_w = h_f @ 60°F = 28.08$ Btu/lbm

$m_w = m_w$

$m_{v_1} = m_{v_1} + m_w$

$\Delta w = w_1 - w_2$

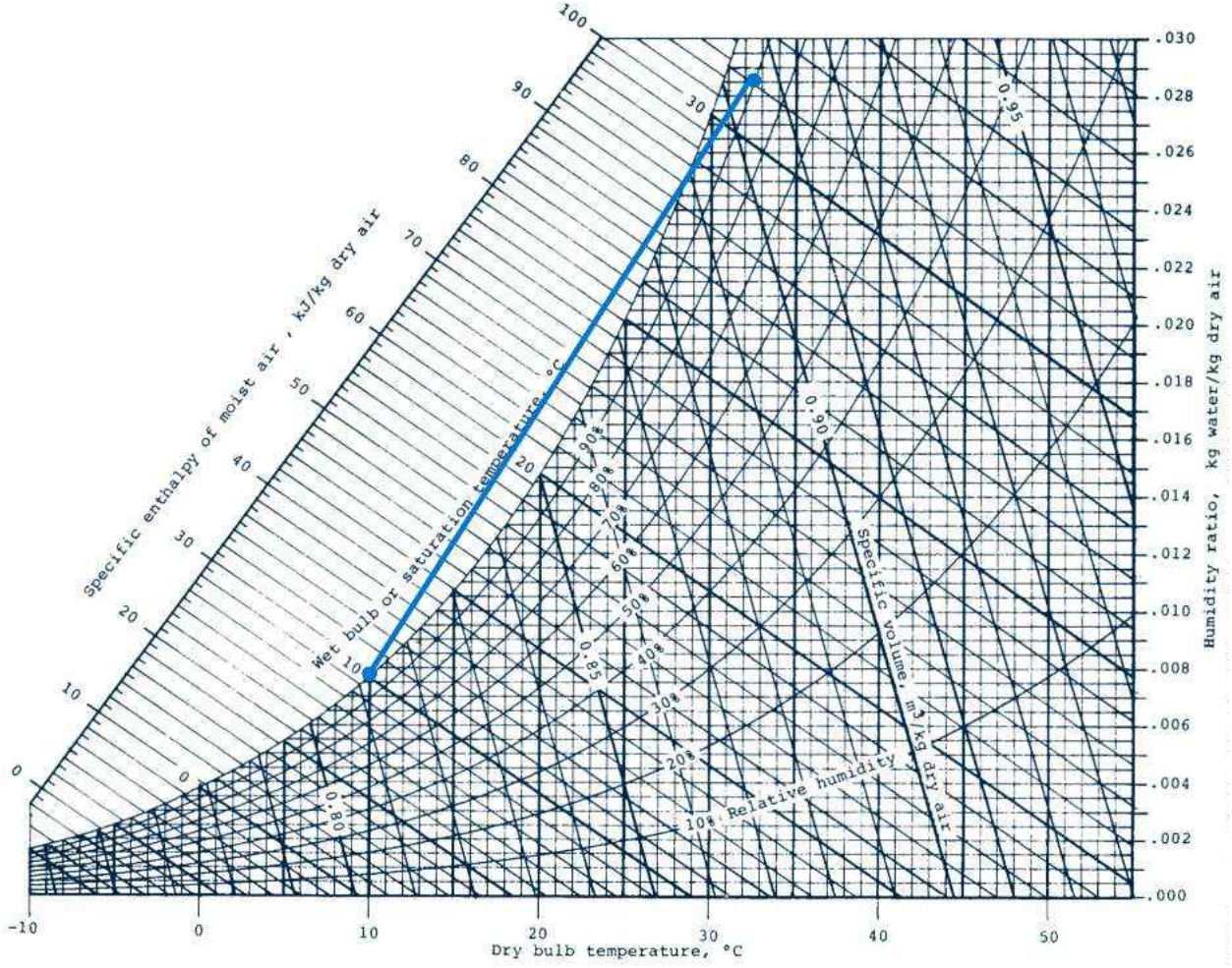
$\Delta w = 0.0278 - 0.0076 = 0.0202$ lbm H_2O/lbm dry air

$\Delta E = E_{in} - E_{out} \rightarrow E_{in} = E_{out}$

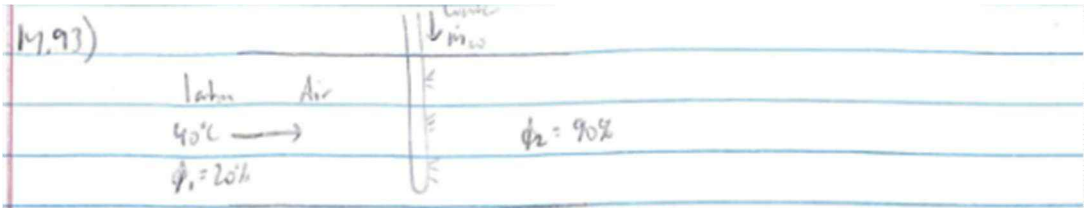
$m_1 h_1 = Q_{out} + m_2 h_2$

$Q_{out} = h_1 - h_2 - (\omega_1 - \omega_2) h_w$

$Q_{out} = 52.22 - 20.20 - (0.0202)\,28.08 = 31.39$ Btu/lbm dry air



M.93)



Given: 1 atm

$T_{db,1} = 40°C$

$\phi_1 = 20\%$

$Q_v = 7\ m^3/min = 0.117\ m^3/s$

$\phi_2 = 90\%$

From psychometric chart:

$\omega_1 = 0.0093\ kg_{H_2O}/kg_{dry\ air}$

$h_1 = 64\ kJ/kg_{dry\ air}$

$h_2 = h_1$

a.) $T_{db,2} = 23°C$

b.) from chart: $\omega_2 = 0.016\ kg_{H_2O}/kg_{Dry\ air}$

$\dot{m}_{a,1} = \rho \dot{Q}_v$ $\qquad \rho = \frac{1}{v} = \frac{1}{0.86}$

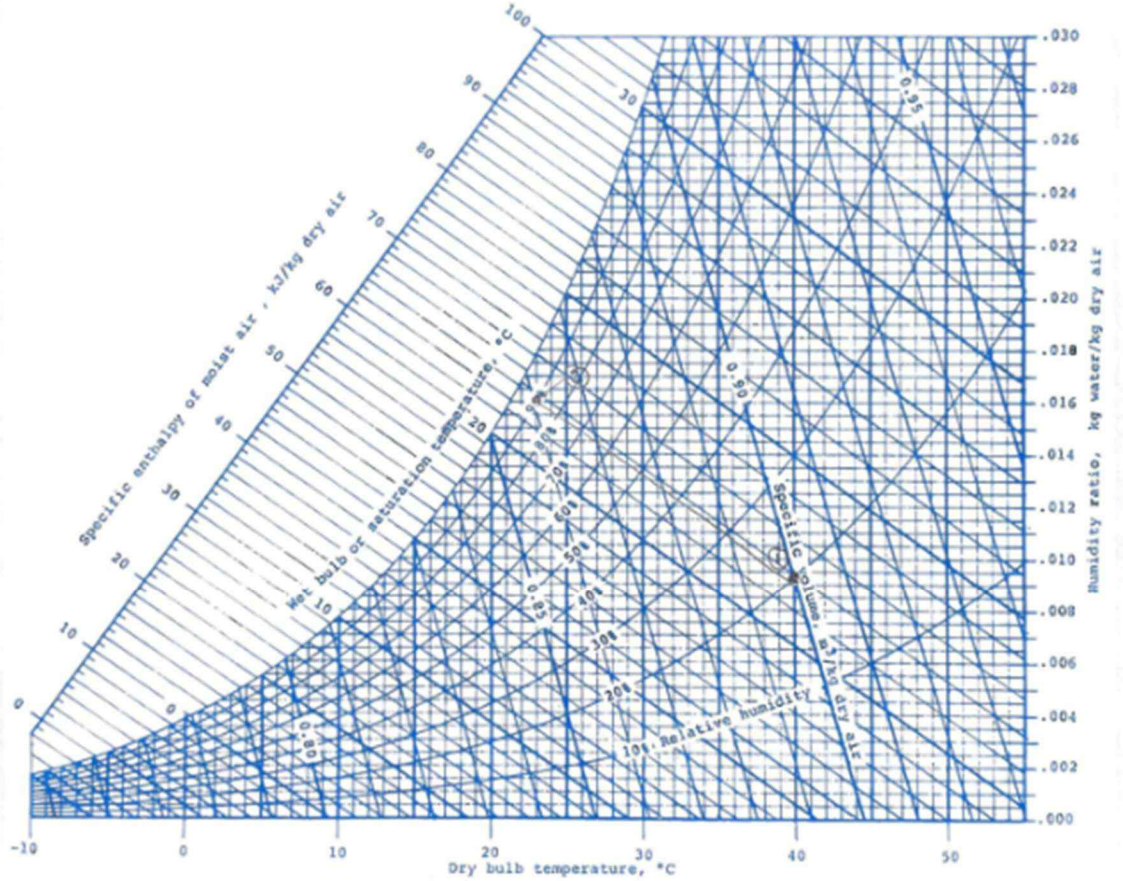
$= \left(\frac{1}{0.86}\right)(0.117)$

$\dot{m}_{a_1} = 0.136\ kg/s$

$\dot{m}_w = \dot{m}_a(\omega_2 - \omega_1)$

$\dot{m}_w = (0.136)(0.016 - 0.0093)$

$\boxed{\dot{m}_w = 9.112 \times 10^{-4}\ kg/s}$


Specific enthalpy of moist air, kJ/kg dry air
Wet bulb or saturation temperature, °C
Humidity ratio, kg water/kg dry air
Dry bulb temperature, °C
Specific volume, m³/kg dry air
Relative humidity
0.95
0.90
0.80
0.50
100
90
80
70
60
50
40
30
20
10
0
-10
.030
.028
.026
.024
.022
.020
.018
.016
.014
.012
.010
.008
.006
.004
.002
.000

100 $T_1 = 35°C$ $\phi_1 = 30\%$ $V_1 = 15\ m^3/min$
$T_2 = 15°C$ $\phi_2 = 90\%$ $V_2 = 25\ m^3/min$
$P = 1\ atm$

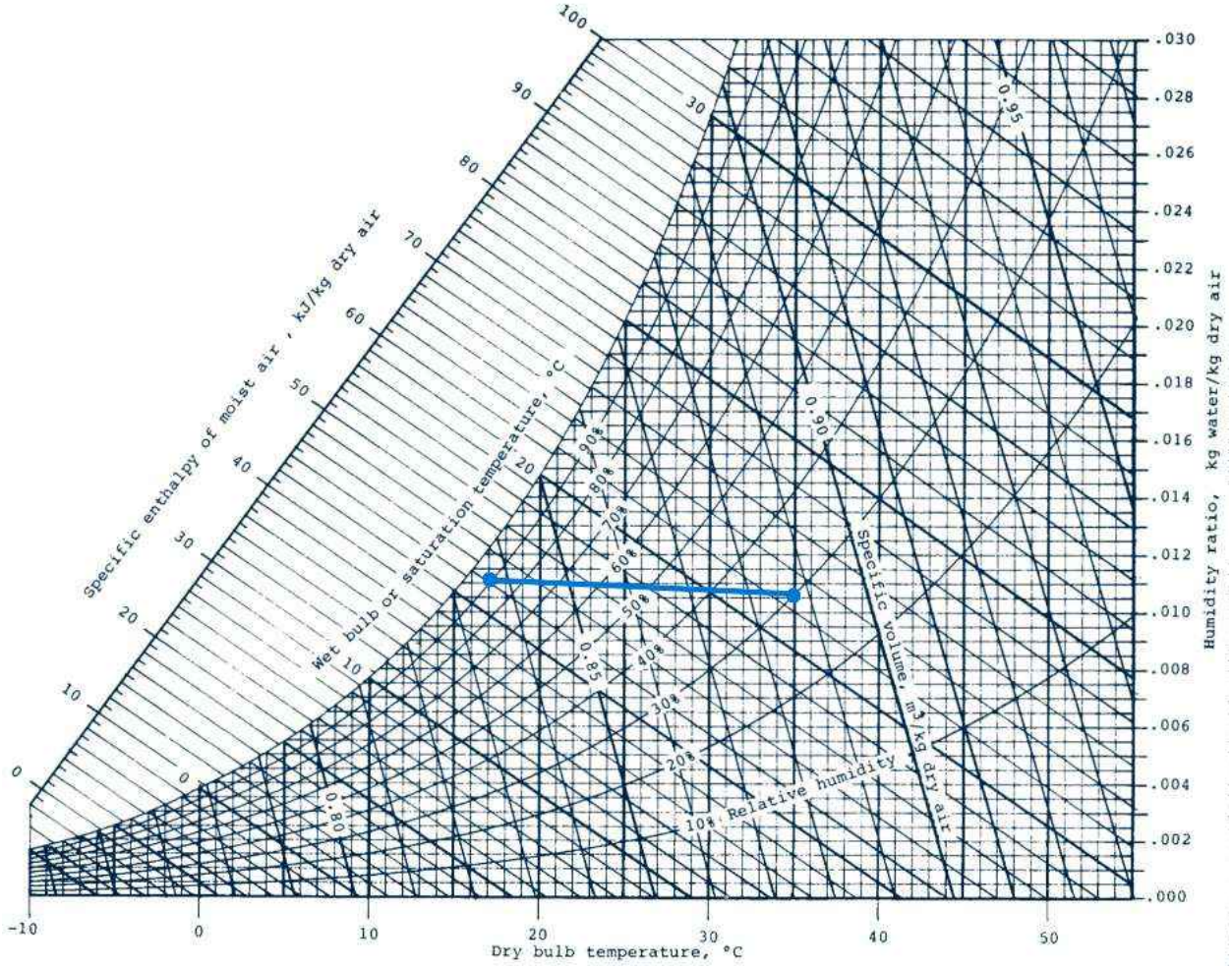
$h_1 = 62.2\ kJ/kg$ $v_1 = 0.89\ m^3/kg$ $w_1 = 0.01054\ kg\ H_2O/kg\ dry\ air$
$\dot{m}_1 = \frac{V_1}{v_1} = \frac{15}{0.89} = 16.85\ kg/min$
$h_2 = 31.5\ kJ/kg$ $v_2 = 0.82\ m^3/kg$ $w_2 = 0.00785\ kg\ H_2O/kg\ dry\ air$
$\dot{m}_2 = \frac{V_2}{v_2} = \frac{25}{0.82} = 30.49\ kg/min$

$\frac{\dot{m}_1}{\dot{m}_2} = \frac{w_2 - w_3}{w_3 - w_1} \rightarrow \frac{16.85}{30.49} = \frac{0.00785 - w_3}{w_3 - 0.01054} \rightarrow w_3 = 0.0088\ kg\ H_2O/kg\ dry\ air$
$\frac{\dot{m}_1}{\dot{m}_2} = \frac{h_2 - h_3}{h_3 - h_1} \rightarrow h_3 = 42.68\ kJ/kg$

from $h_3 = 42.68$ and $w_3 = 0.0088$
$T_3 = 20.2°C$
$\phi = 59.7\%$
$v_3 = 0.84\ m^3/kg$

$\dot{m}_3 = \dot{m}_1 + \dot{m}_2 = 16.85 + 30.45 = 47.34\ kg/min$

$V_3 = \dot{m}_3 \cdot v_3 = 47.34 \cdot 0.84 = 39.77\ m^3/min$


Specific enthalpy of moist air , kJ/kg dry air
Wet bulb or saturation temperature, °C
Humidity ratio, kg water/kg dry air
Dry bulb temperature, °C
Specific volume, m³/kg dry air
Relative humidity
0.95
0.90
0.85
0.80
90%
80%
70%
60%
50%
40%
30%
20%
10%
-10
0
10
20
30
40
50
.030
.028
.026
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.004
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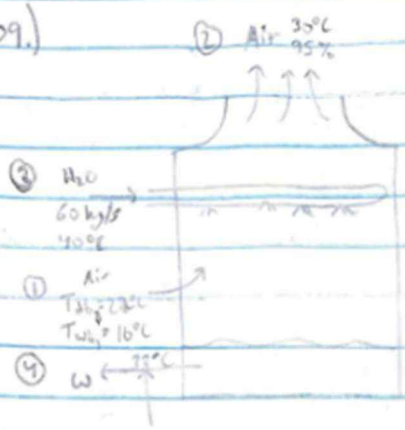
14-109.)



$\dot{m}_3 = 60 kg/s$ $T_1, T_2 = 30°C$ $c_{p\,H_2O@40°C} = 4.18 kJ/kg \cdot K$

$T_2 = 40°C$ ϕ_2 95%

$T_4 = 33°C$ $T_{db,air,in} = 22°C$

$T_{wb,air,in} = 16°C$

From Table A-4:

at 22°C $h_a = 92.28 kJ/kg$

at 16°C $h_a = 67.17 kJ/kg$

$h_4 = 138.28 kJ/kg$

From psychrometric chart:

$h_1 = 45 kJ/kg\ dry\ air$

$\omega_1 = 0.009\ kg_w/kg\ dry\ air$

$h_2 = 96.3 kJ/kg\ dry\ air$

$\omega_2 = 0.026\ kg_w/kg\ dry\ air$

$v_1 = 0.848\ m^3/kg\ dry\ air$

$V_2 = 0.895\ m^3/kg\ dry\ air$

Dry air: $\dot{m}_{a1} = \dot{m}_{a2} = \dot{m}_a$

Water: $\dot{m}_3 + \dot{m}_{a1}\omega_1 = \dot{m}_4 + \dot{m}_{a2}\omega_2$

$$\dot{m}_a = \frac{\dot{m}_3(h_3 - h_4)}{(h_2 - h_1) - (\omega_2 - \omega_1)h_4}$$

$$\dot{m}_a = \frac{\dot{m}_3 c_p (T_3 - T_4)}{(h_2 - h_1) - (\omega_2 - \omega_1)h_4}$$

$$\dot{m}_a = \frac{60\ kg/s \cdot 4.18\ kJ/kg\cdot K\,(40-33)K}{(96.3-75)\frac{kJ}{kg\ Dryair} - (.026-0.009)\frac{kg_w}{kg\ dryair}\cdot 138.28\frac{kJ}{kg}}$$

$$\dot{m}_a = \frac{1755.6}{48.949\ kg\ dryair}$$

$$\dot{m}_a = 35.87\ kg\ dryair/s$$

a.) $\dot{V}_1 = v_1 \dot{m}_a$

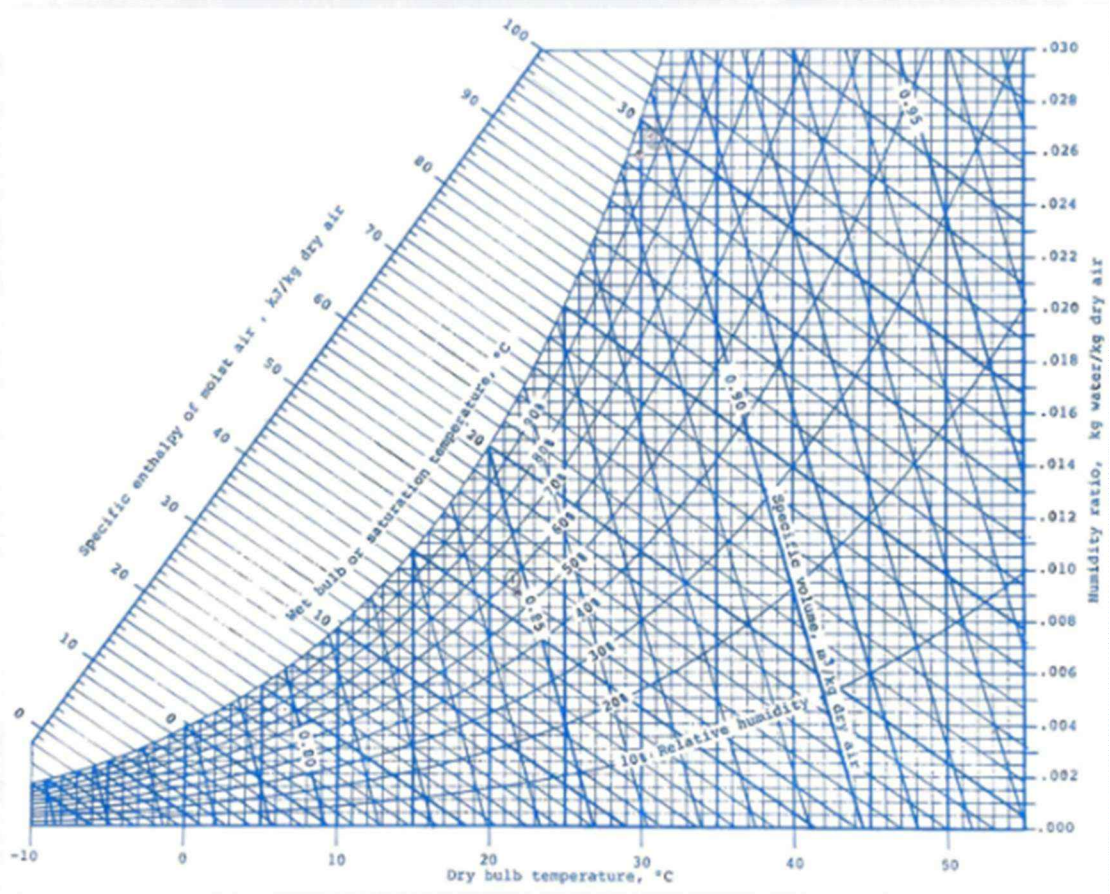
$\dot{V}_1 = (0.848\ m^3/kg\ dryair)(35.87\ kg\ dryair/s)$

$\boxed{\dot{V}_1 = 30.42\ m^3/s}$

b.) $\dot{m}_{makeup} = \dot{m}_a(\omega_2 - \omega_1)$

$\dot{m}_{makeup} = 35.87\ kg\ dryair/s\ (0.026-0.009)\frac{kg_w}{kg\ dryair}$

$\boxed{\dot{m}_{makeup} = 0.61\ kg_w/s}$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Specific volume, m³/kg dry air
Relative humidity
Dry bulb temperature, °C
-10
0
10
20
30
40
50
.000
.002
.004
.006
.008
.010
.012
.014
.016
.018
.020
.022
.024
.026
.028
.030
0.85
0.50
0.15
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%