MET 350	HW #5	ML SUNDERLAND

1)

14) <u>Given</u> $T_{air} = 20°C$, $P_{air} = 85\,kPa$ $\phi_{air} = 85\%$

<u>Find</u> a) partial pressure of dry air

b) specific humidity of air (ω_{air})

c) ethalpy of dry air ($h_{air,dry}$)

Sol: $T = 293\,K \Rightarrow C_p = 1.005\ kJ/kg\text{-}K$

$P_{sat,20°C} = 2.3392\ kPa$

$h_{g,20°C} = 2537.4\ kJ/kg$

a) $P_a = P - P_v$ $\quad P_v = \phi P_g = .85(2.3392)$

$P_a = 85 - 1.7544$ $\quad P_v = 1.7544\ kPa$

$\boxed{P_a = 83.25\ kPa}$

b) $\omega = \dfrac{0.622 P_v}{P - P_v} = \dfrac{0.622(1.7544)}{85 - 1.7544}$

$\boxed{\omega = 0.013\ kJ/kg\ dry\ air}$

c) $h = h_a + \omega h_v$

$= 1.005(20) + .0131(2537.4)$

$\boxed{h = 53.34\ kJ/kg}$

16 **Given** $V = 8\,m^3$

Saturated Air @ 30°C, $P = 105$ kPa

FIND
a) Mass of dry air
b) specific humidity (ω)
c) enthalpy of air per unit mass dry air

SOL

$T = 303$ K

$P_{sat,30^\circ C} = 4.2469$ kPa

$c_p = 1.005$ kJ/kg·K

$h_{g,30^\circ C} = 2555.6$ kJ/kg

$P_a = 105 - 4.2469$

$P_a = 100.753$ kPa

$P_v = 4.2469$

a) $$m_a = \frac{P_a V_a}{R_a T} = \frac{100.75\,\text{kPa} \cdot 8\,m^3}{(0.287\,\text{kPa}\cdot m^3/\text{kg}\cdot K)\,303\,K}$$

$$\boxed{m_a = 9.27\ \text{kg}}$$

b) $$\omega = \frac{.622\,P_v}{P - P_v} = \frac{.622\,(4.2469)}{105 - 4.2469}$$

$$\boxed{\omega = 0.0262\ \text{kg/kg dry air}}$$

c) $$h = c_p T + \omega h_g$$
$$= 1.005(30) + .0262(2555.6)$$

$$\boxed{h = 97.1\ \text{kJ/kg dry air}}$$

18) Given: Humid Air

$P_1 = 100$ kPa

$T_1 = 20°C = 293$ K

$\phi_1 = 90\%$

Compressed in steady flow, isentropic compressor to 800 kPa

FIND

a) relative humidity of air at outlet

SOL

$P_2 = 800$ kPa

$K = \frac{c_p}{c_v} = \frac{1.005}{.718} = 1.4$

$T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}}$

$= 293 \left(\frac{800}{100}\right)^{\frac{1.4-1}{1.4}}$

$T_2 = 257.8°C$

$P_{sat, 20°C} = 2.3392$ kPa

$P_{v_1} = .9(2.3392) = 2.105$ kPa

200

$w = \frac{.622 P_v}{P - P_v} = \frac{.622(2.105)}{100 - 2.105}$

$w_1 = 0.0134$ kg/kg dry air $= w_2$

$P_{sat, 257.8°C} = 4530$ kPa

18 cont

$$\omega_2 = \frac{.0622(P_{2v})}{P_2 - P_{2v}}$$

$$\omega_2 P_2 - \omega_2 P_{2v} = 0.622\, P_{2v}$$

$$\omega_2 P_2 = .622 P_{2v} + \omega_2 P_{2v}$$

$$\omega_2 P_2 = P_{2v}\,(0.622 + \omega_2)$$

$$P_{2v} = \frac{\omega_2 P_2}{0.622 + \omega_2} = \frac{.0134\,(800)}{0.622 + .0134}$$

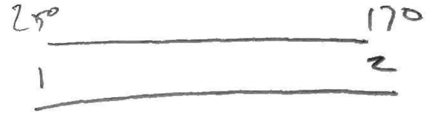
$$P_{2v} = 16.87 \text{ kPa}$$

$$\phi_{outlet} = \frac{P_{2v}}{P_{2,sat}} = \frac{16.87 \text{ kPa}}{4530 \text{ kPa}} = \boxed{.372\,\%}$$

28) Given Dry + Wet Bulb of Air

$P = .95\ kPa$

$T_2 = 25°C \quad T_1 = 17°C$



FIND
a) ω_1
b) ϕ
c) h

$h_{fg_2} = 2460.64\ kJ/kg$

$h_{f_2} = 71.3552\ kJ/kg$

$h_{g_1} = 2546.5\ kJ/kg$

SOL

$$\omega_1 = \frac{c_p (T_2 - T_1) + \omega_2 h_{fg,2}}{h_{g_1} - h_{f_2}}$$

$$\omega_2 = \frac{.622 P_{g_2}}{P_2 - P_{g_2}}$$

$P_{g_{1},25°C} = 3.1698\ kPa$

$P_{g_{2},17°C} = 1.9591\ kPa$

$$= \frac{.622(1.9591)}{95 - 1.9591}$$

$\omega_2 = .0131\ kg/kg\ dry\ air$

$$\omega_1 = \frac{1.005(17-25) + .0131(2460.64)}{2546.5 - 71.3552}$$

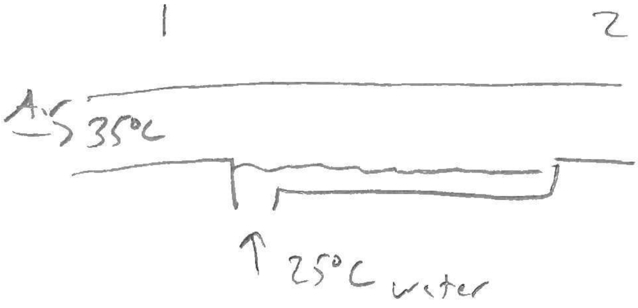
$\omega_1 = .0098\ kg_{H_2O}/kg\ dry\ air$

$$\phi = \frac{\omega_1 P_2}{(.622 + \omega) P_{g_1}} = \frac{(.0098)(95)}{(.622 + .0098)(3.1698)} = \boxed{46\%}$$

$$h = h_a + \omega_1 h_g = 1.005(25) + .0098(2546.5) = \boxed{49.8\ kJ/kg}$$

$h = c_p T + \omega_1 h_g$

32)



Adiabatic Saturation device

- leaves as Saturated air mixture

$P = 98$ kPa

FIND a) ϕ

b) ω

$T_1 = 35°C$

$T_2 = 25°C$

$h_{fg_2} = 2441.7$

$h_{g_1} = 2564.6$

$h_{f_2} = 104.83$

$\Rightarrow \phi_1 = 1$

$$\omega_1 = \frac{c_p(T_2 - T_1) + \omega_2 h_{fg_2}}{h_{g_1} - h_{f_2}}$$

$$\omega_2 = \frac{.622\, P_{g_2}}{P_2 - P_{g_2}} = \frac{.622(3.1698)}{98 - 3.1698}$$

$P_{g_2} = 3.1698$ kPa

$\omega_2 = .0208$ kg/kg dry air

$$\omega_1 = \frac{1.005(25-35) + .0208(2441.7)}{2564.6 - 104.83}$$

$\omega_1 = 0.0166$ kg/kg dry air

$$\phi_1 = \frac{\omega_1 P}{(.622 + \omega_1)(P_{g_1})} = \frac{.0166(98\text{ kPa})}{(.622 + .0166)(3.1698)} = 80\%$$

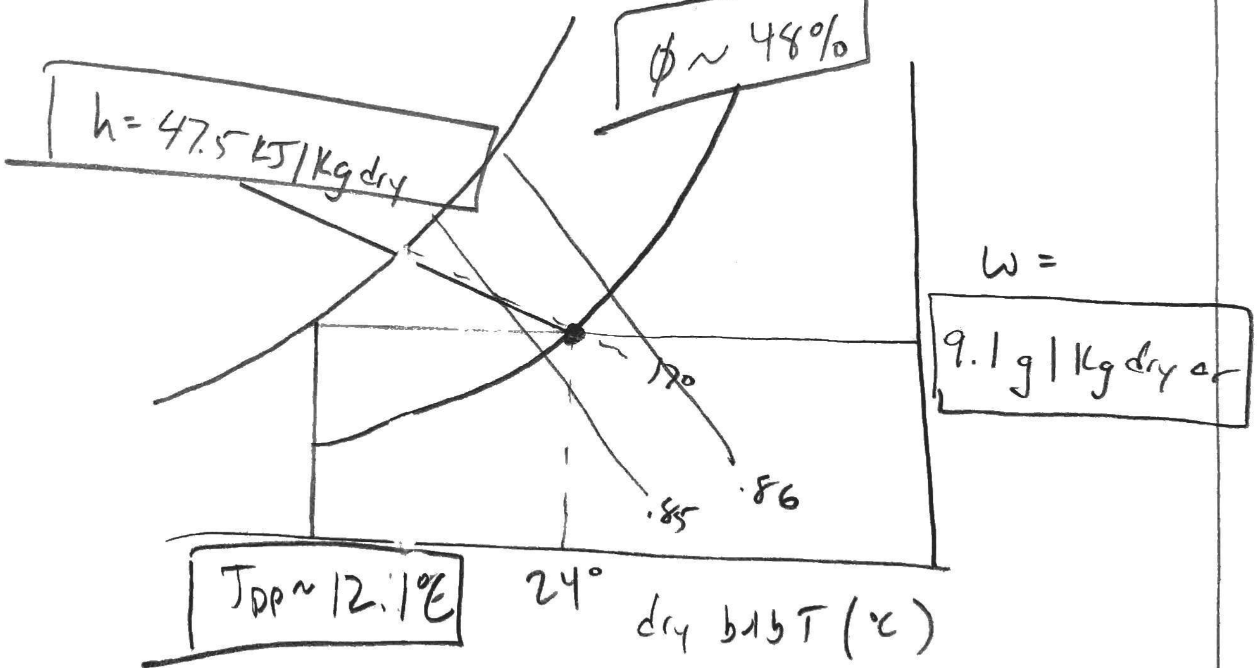
14-39 Given: 1 atm

$T_1 = 24°C$ $T_2 = 17°C$ $T_{DB} = 24°C$

$T_{WB} = 17°C$

Using chart find

a) specific humidity (ω)
b) enthalpy (h)
c) relative humidity (ϕ)
d) dew point temp
e) specific volume of air in m^3/kg



=> specific volume

~ .855 m^3/kg

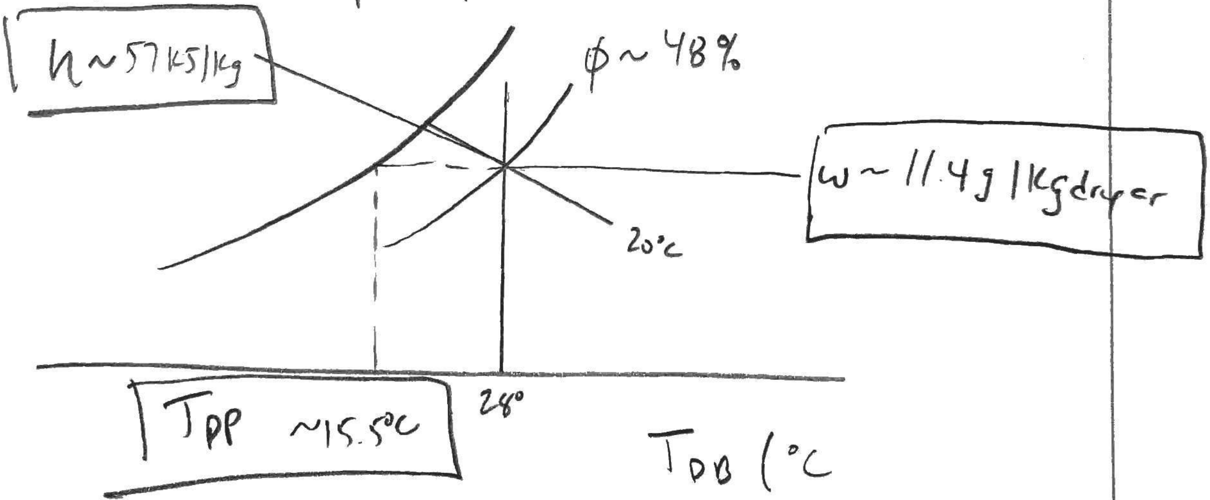
14-41

$P = 1$ atm

$T_{DB} = 28°C$

$T_{WB} = 20°C$

FIND
a) relative humidity
b) humidity ratio
c) enthalpy
d) dew point temp
e) water vapor pressure



$P_{v28} = 3.81606$

$P_v = \phi P_{v28°C}$

$= .48(3.81606)$

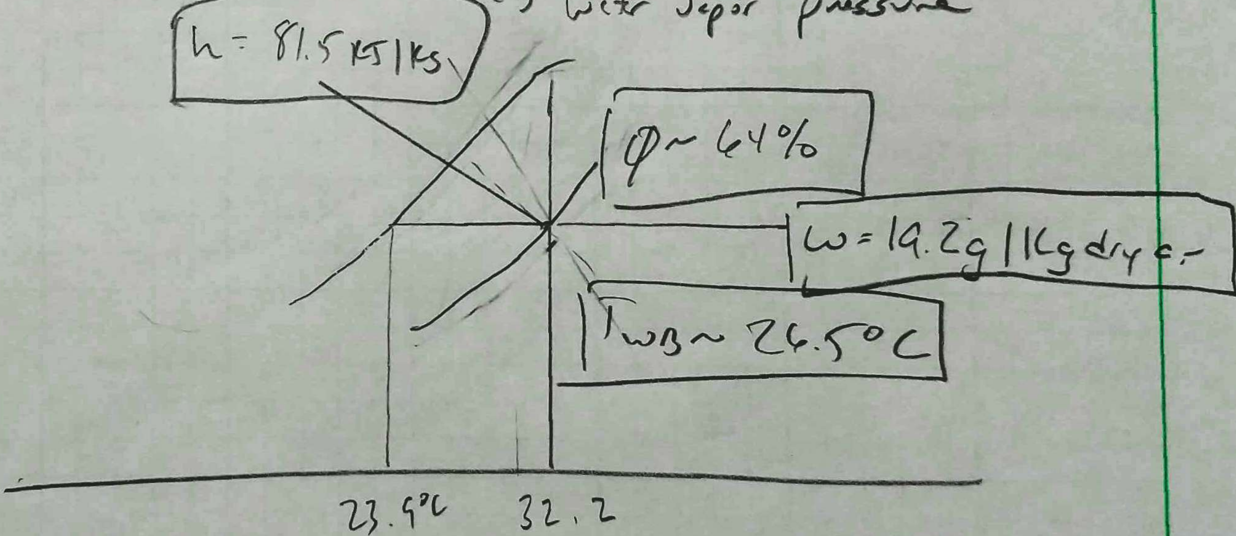
$P_v = 1.832$ kPa

14-43 Air $P = 1\,atm$

$T_{DB} = 90°F = 32.2°C$

$T_{DP} = 75°C = 23.9°C$

Using chart Find
a) ϕ
b) ω
c) enthalpy
d) T_{WB}
e) water vapor pressure



$1.891\ m^3/kg$ dry air