$45W = \dot{m}_v 2500 (kJ/kg)$

$\dot{m}_v = \frac{45}{2500} = 0.018$ ~~kg~~ g/s

Table 8-11 Rates of Heat Gain from Occupants of Conditioned Spaces[a]

Degree of Activity	Typical Application	Total Heat Adults, Male, Btu/hr	Total Heat Adults, Male, W	Total Heat Adjusted,[b] Btu/hr	Total Heat Adjusted,[b] W	Sensible Heat, Btu/hr	Sensible Heat, W	Latent Heat, Btu/hr	Latent Heat, W
Seated at theater	Theater—Matinee	390	114	330	97	225	66	105	31
Seated at theater	Theater—Evening	390	114	350	103	245	72	105	31
Seated, very light work	Offices, hotels, apartments	450	132	400	117	245	72	155	45
Moderately active office work	Offices, hotels, apartments	475	139	450	132	250	73	200	59
Standing, light work; walking	Department store, retail store	550	162	450	132	250	73	200	59
Walking; standing	Drugstore, bank	550	162	500	146	250	73	250	73
Sedentary work	Restaurant[c]	490	144	550	162	275	81	275	81
Light bench work	Factory	800	235	750	220	275	81	475	139
Moderate dancing	Dance hall	900	264	850	249	305	89	545	160
Walking 3 mph; light machine work	Factory	1000	293	1000	293	375	110	625	183
Bowling[d]	Bowling alley	1500	440	1450	425	580	170	870	255
Heavy work	Factory	1500	440	1450	425	580	170	870	255
Heavy machine work; lifting	Factory	1600	469	1600	469	635	186	965	283
Athletics	Gymnasium	2000	586	1800	528	710	208	1090	320

[a]Tabulated values are based on 75 F room dry-bulb temperature. For 80 F room dry-bulb, the total heat remains the same, but the sensible heat values should be decreased by approximately 20%, and the latent heat values increased accordingly.

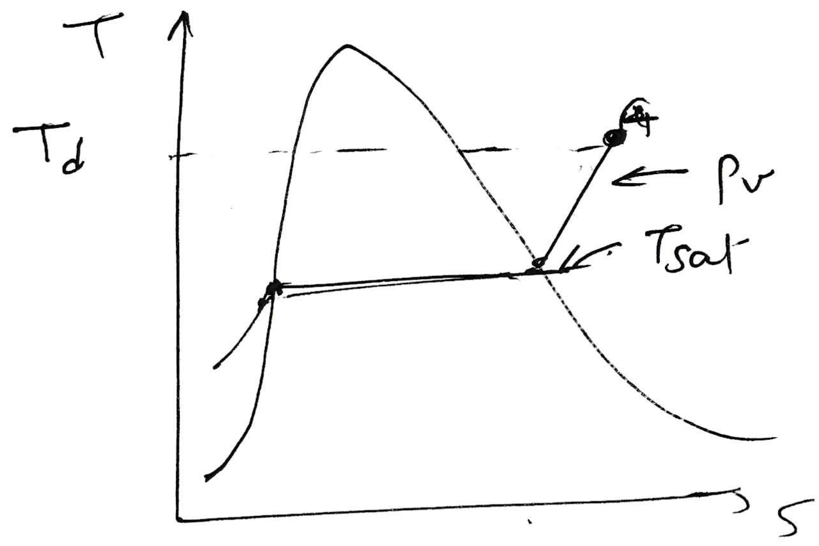
[b]*Adjusted heat gain* is based on normal percentage of men, women, and children for the application listed, with the postulate that the gain from an adult female in 85% of that for an adult male, and that the gain from a child is 75% of that for an adult male.

[c]Adjusted total gain for *Sedentary work, Restaurant,* includes 60 Btu/hr for food per individual (30 Btu/hr sensible and 30 Btu/hr latent).

[d]For Bowling, figure one person per alley actually bowling, and all others as sitting (400 Btu/hr) or standing and walking slowly (550 Btu/hr).

Source: Reprinted by permission from ASHRAE *Cooling and Heating Load Calculation Manual*, 2nd ed., 1992.

Humid Specific heat



$$h = C_{pa}T + \omega\, h_v(T)$$

$$= C_{pa}T + \omega\left[h_f(T_{sat}) + h_{fg}(T_{sat}) + C_{ps}(T - T_{sat})\right]$$

$C_{ps} = 1.9\ \text{kJ/kg K}$

$h_f(T_{sat}) = C_{pw} T_{sat}$

$= 4.2\, T_{sat}$

$C_{pa} = 1.005\ \text{kJ/kg K}.$

$$h = C_{pa}T + \omega\left[C_{pw}T_{sat} + h_{fg}(T_{sat}) + C_{ps}T - C_{ps}T_{sat}\right]$$

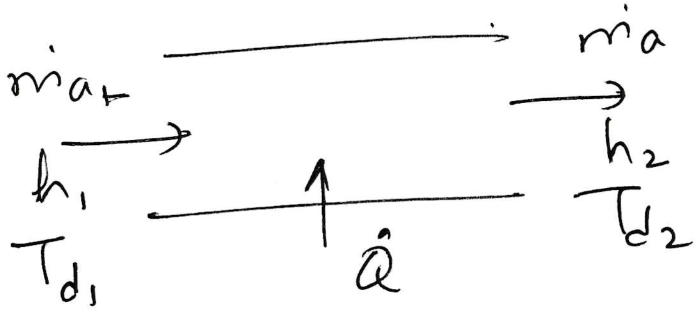
$$= C_{pa}T + \omega\left[(C_{pw} - C_{ps})\,T_{sat} + h_{fg}(T_{sat}) + C_{ps}T\right]$$

$$= \cancel{1.005}\,(C_{pa} + C_{ps}\,\omega]\,T + \omega\left[(C_{pw} - C_{ps})\,T_{sat} + h_{fg}(T_{sat})\right]$$

$$\simeq 1.022\,T + \omega\, 2500$$

$$\boxed{h = 1.022\,T + 2500\,\omega}$$

$C_{ph} \Rightarrow$ humid specific heat.



SENSIBLE HEATING

$$\dot m_a h_1 - \dot m_a h_2 + \dot Q = 0$$

$$\dot Q = \dot m_a (h_2 - h_1)$$

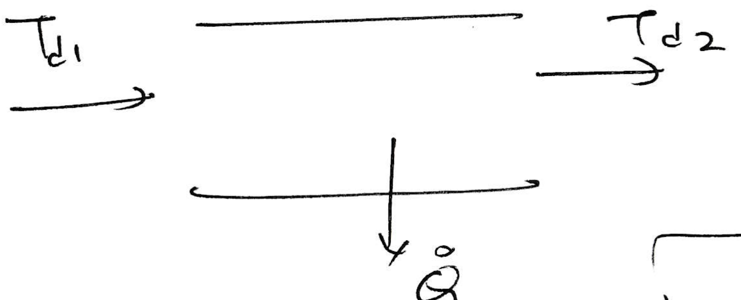
$$= \dot m_a \left[(1.022)\, T_{d_2} + 2500 \omega_2 - (1.022)\, T_{d_1} - 2500 \omega_1 \right]$$

Since $\omega_1 = \omega_2$

$$\dot Q = \dot m_a \, C_{ph} (T_{d_2} - T_{d_1})$$

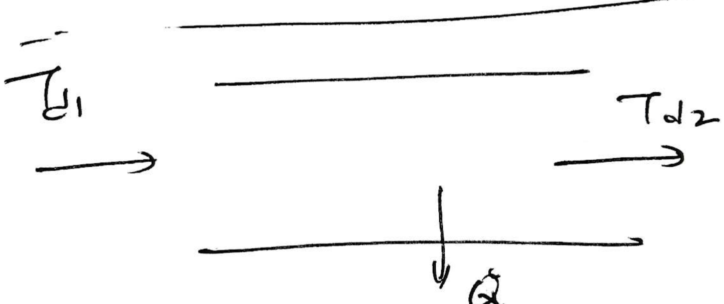
SENSIBLE COOLING

Cooling



If $T_{d_2} > T_{dew\ point}$,

$$\dot Q = \dot m_a \, C_{ph} (T_{d_2} - T_{d_1})$$

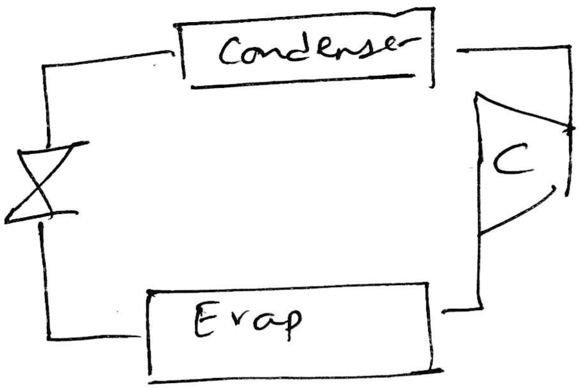


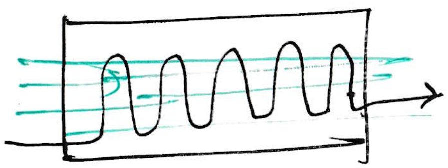
$$\dot Q = \dot m_a (h_2 - h_1)$$

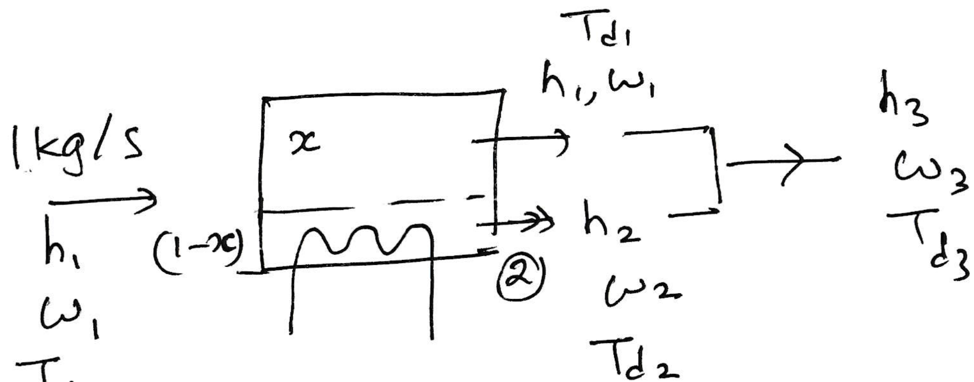
$$= \dot m_a \left[C_{ph} T_{d_2} + 2500 \omega_2 - C_{ph} T_{d_1} - 2500 \omega_1 \right]$$

$$= \underbrace{\dot m_a C_{ph} (T_{d_2} - T_{d_1})}_{\text{Sensible cooling load}} + \underbrace{\dot m_a (\omega_2 - \omega_1)\, 2500}_{\text{Latent cooling load.}}$$

By-pass Ratio







Mass Balance

$$x\omega_1 + (1-x)\omega_2 = \omega_3$$

$$x(\omega_1 - \omega_2) = \omega_3 - \omega_2$$

$$\Rightarrow \quad x = \frac{\omega_3 - \omega_2}{\omega_1 - \omega_2}$$

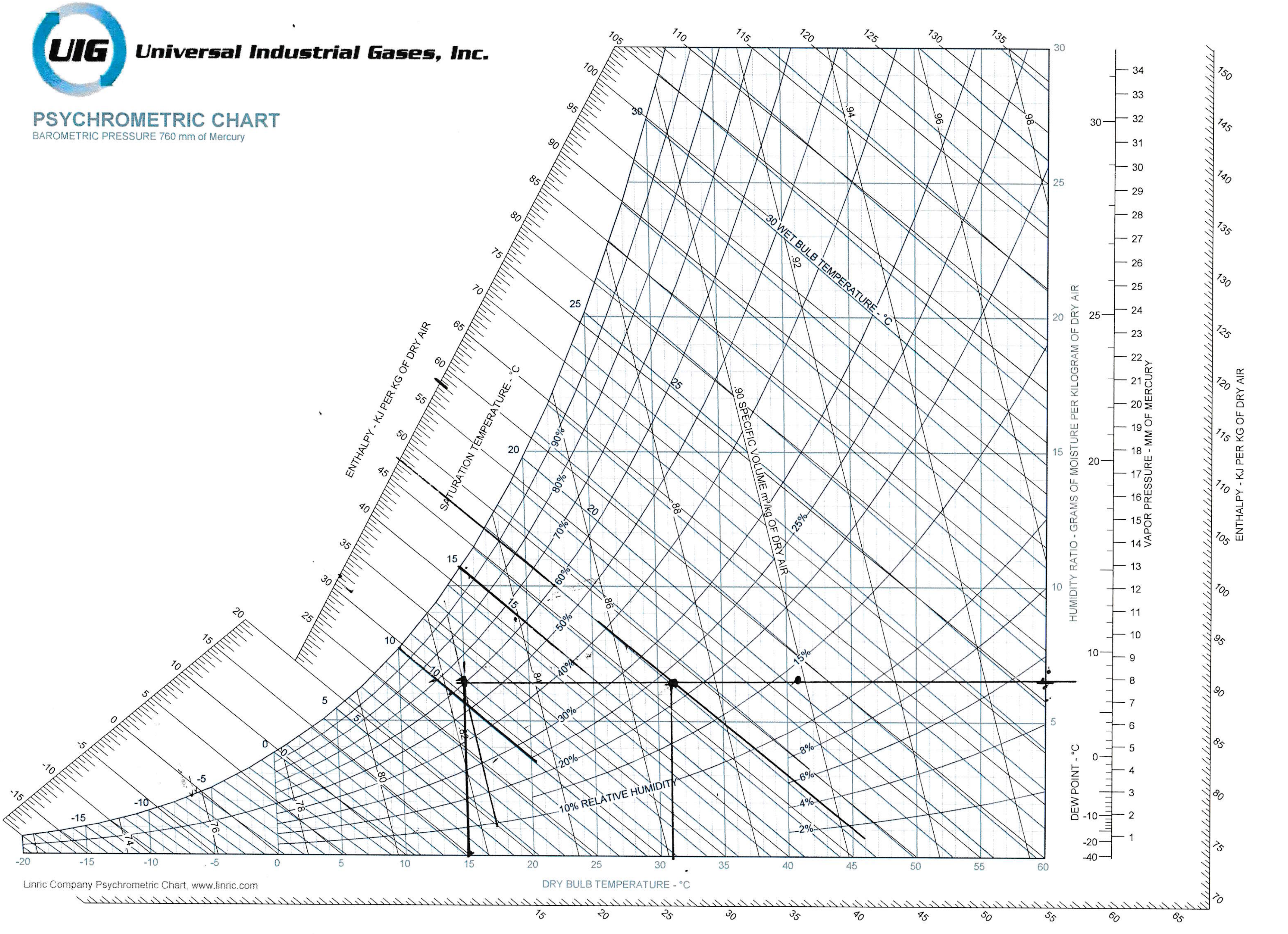
Enthalpy Balance

$$h_1 x + h_2(1-x) = h_3$$

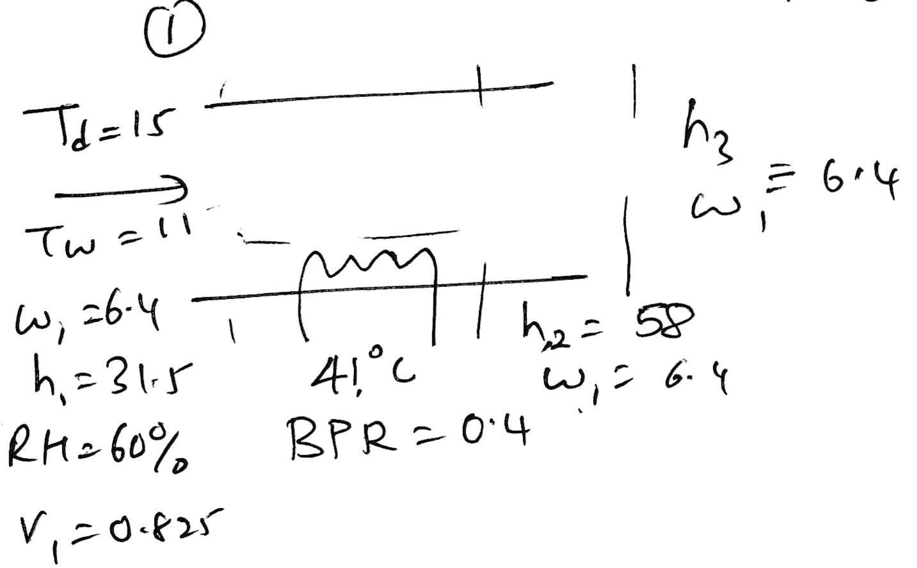
$$\Rightarrow \quad \cancel{h_3} \quad x = \frac{h_3 - h_2}{h_1 - h_2}$$

By-pass Ratio.

$$x = \frac{T_{d_3} - T_{d_2}}{T_{d_1} - T_{d_2}}$$


UIG Universal Industrial Gases, Inc.
PSYCHROMETRIC CHART
BAROMETRIC PRESSURE 760 mm of Mercury
ENTHALPY - KJ PER KG OF DRY AIR
SATURATION TEMPERATURE - °C
30 WET BULB TEMPERATURE - °C
.90 SPECIFIC VOLUME m³/kg OF DRY AIR
10% RELATIVE HUMIDITY
HUMIDITY RATIO - GRAMS OF MOISTURE PER KILOGRAM OF DRY AIR
VAPOR PRESSURE - MM OF MERCURY
DEW POINT - °C
DRY BULB TEMPERATURE - °C
Linric Company Psychrometric Chart, www.linric.com

Atmospheric air at 1 atm, dry bulb temperature of 15C and wet bulb temperature of 11C enters a heating coil whose temperature is 41C. If the by-pass ratio is 0.4, determine the dry bulb temperature and relative humidity at the exit. Also determine the sensible heat added to the air per kg of dry air



$$h_3 = x h_1 + (1-x) h_2$$
$$= (0.4)\, 31.5 + (1-0.4)\, 58$$
$$= 47.4 \text{ kJ/kg}$$

$T_d = 31^\circ C$

RH = 24%

Sensible heat added $= (h_2 - h_1)(1-x)$
$$= (58 - 31.5)(0.6)$$
$$= 15.9 \text{ kJ/kg}$$