Advanced Building Science

- Pyschrometrics
  - Key aspects of the psychrometric chart
  - Using the chart to plot basic processes
  - Using the chart to solve specific problems

- Readings
  - HF: Chapter 1.1 to 1.16
  - HPE: Chapter 3.4

Pyschrometrics

- The science that deals with the physical laws governing the mixture of air and water vapor

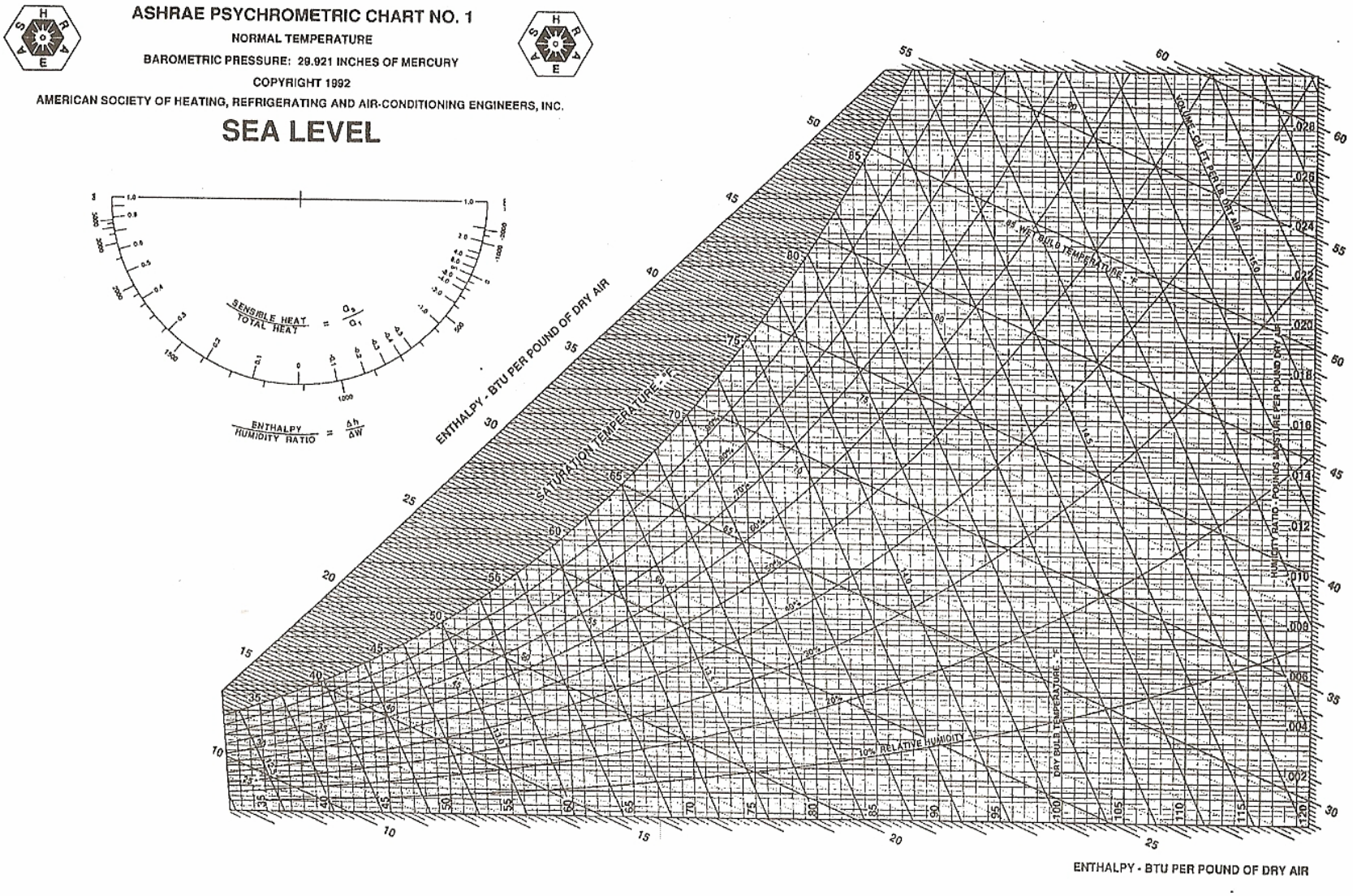
- An applied science that involves …
  - the properties of moist air
  - the processes in which the temperature and/or water vapor content of the mixture are changed.

Pyschrometrics

- Mixture of two non-reacting nearly ideal gases
  - dry air (molecular mass = 28.96)
  - water vapor (molecular mass = 18.01)

- It can be simply explained and is based on:
  - the ideal gas equation => $pV = nRT$
  - Dalton's model of partial pressures => $P_{TOT} = P_{DA} + P_{WV}$
  - conservation of energy
  - conservation of mass

Figure A4-6 *No. 1 IP—Normal Temperature—Sea Level.*



Source: ASHRAE Handbook Fundamentals 2009 Chapter 1

Understanding Psychrometrics

By: Donald P. Gatley

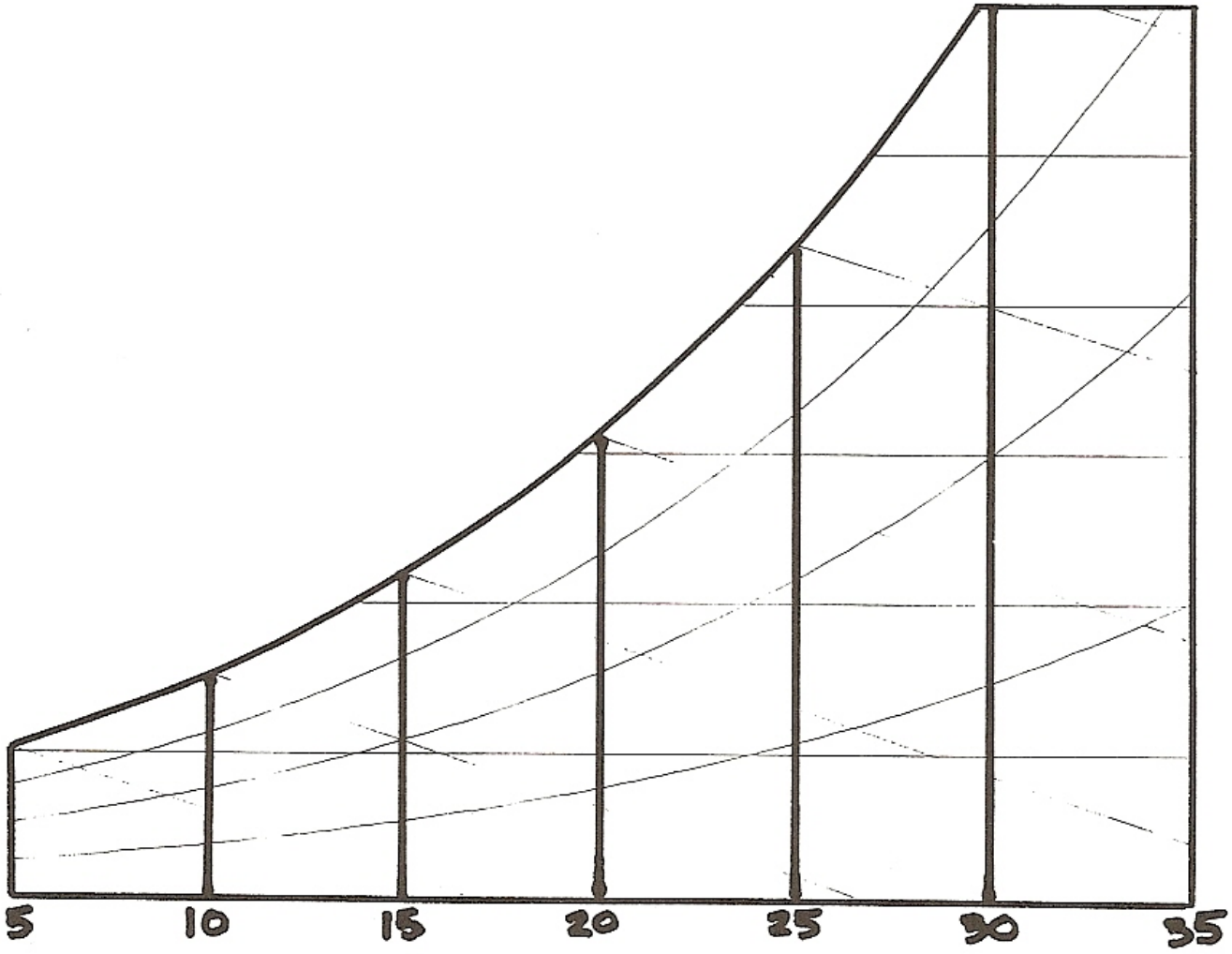


Figure 10-1 *Dry-bulb temperature (t_{DB} in units of °C).*

Source: Gatley, Understanding Psychrometrics, Chapter 10

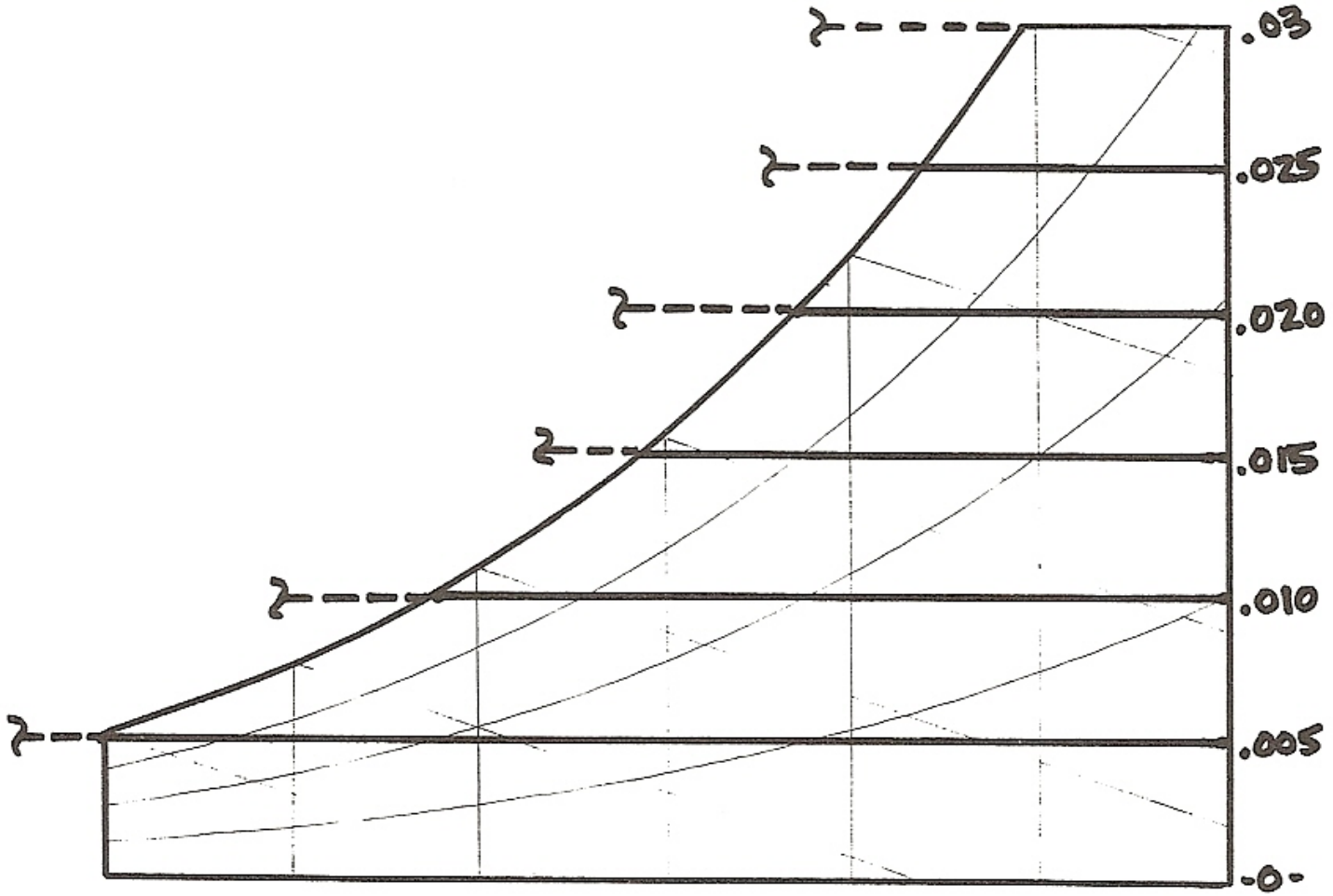


Figure 17-1 *Humidity ratio isolines (W in units of kg_{WV}/kg_{DA} [lb_{WV}/lb_{DA}]).*

Source: Gatley, Understanding Psychrometrics, Chapter 17

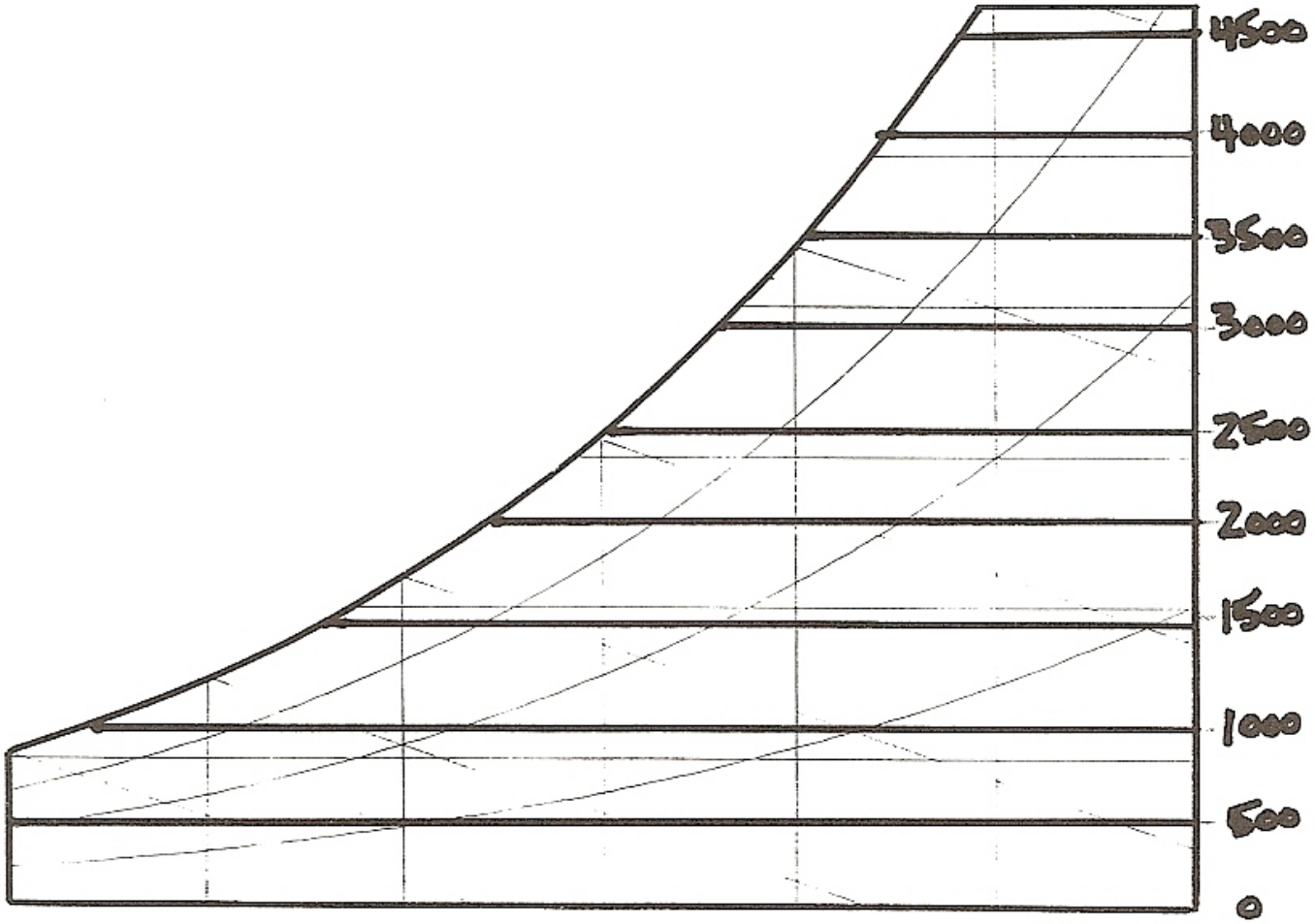


Figure 18-1 *Water vapour pressure isolines (P_{WV} in units of Pa [in. Hg]).*

Source: Gatley, Understanding Psychrometrics, Chapter 17

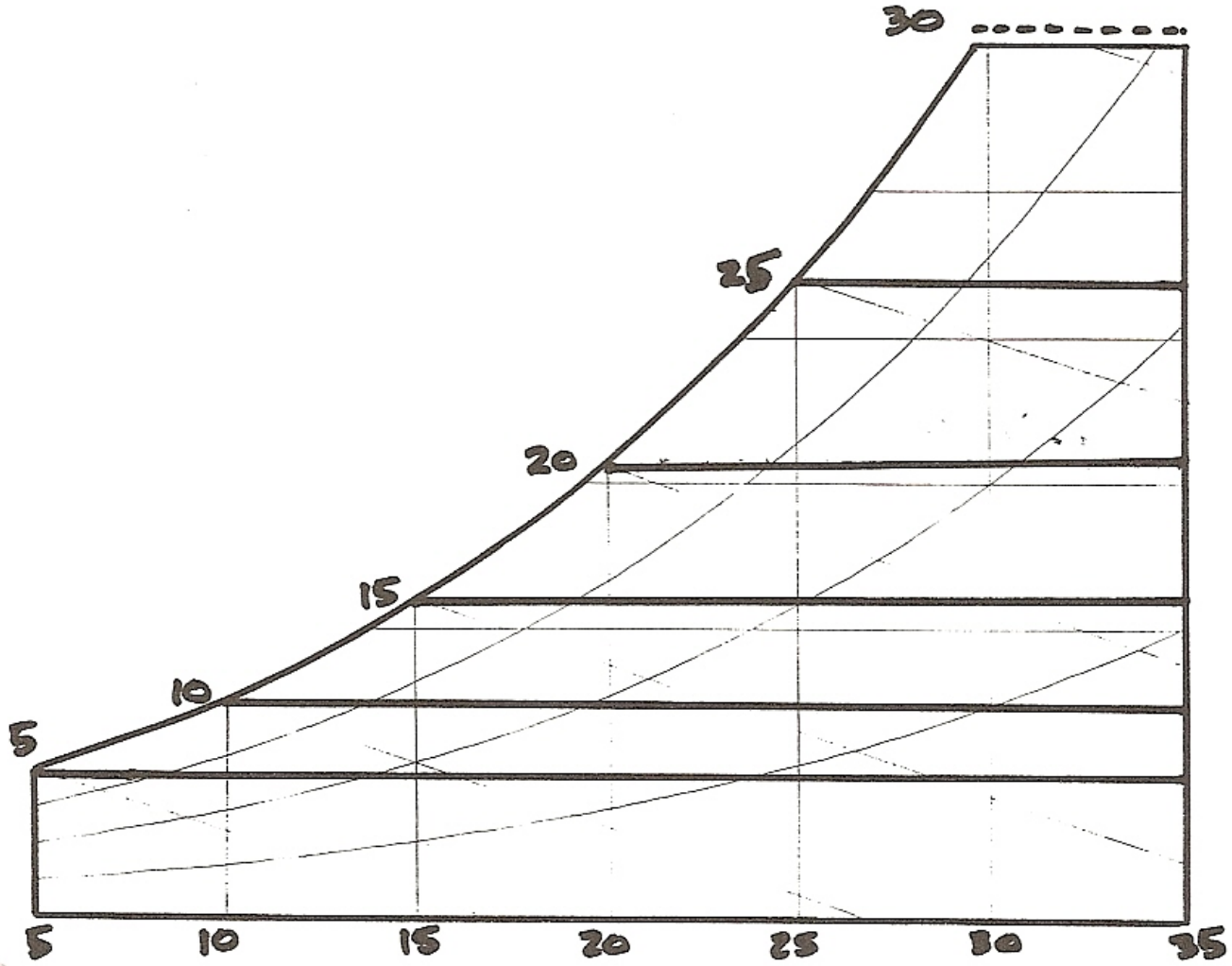


Figure 12-1 *Dew-point temperature isolines (t_{DP} in units of °C).*

Source: Gatley, Understanding Psychrometrics, Chapter 12

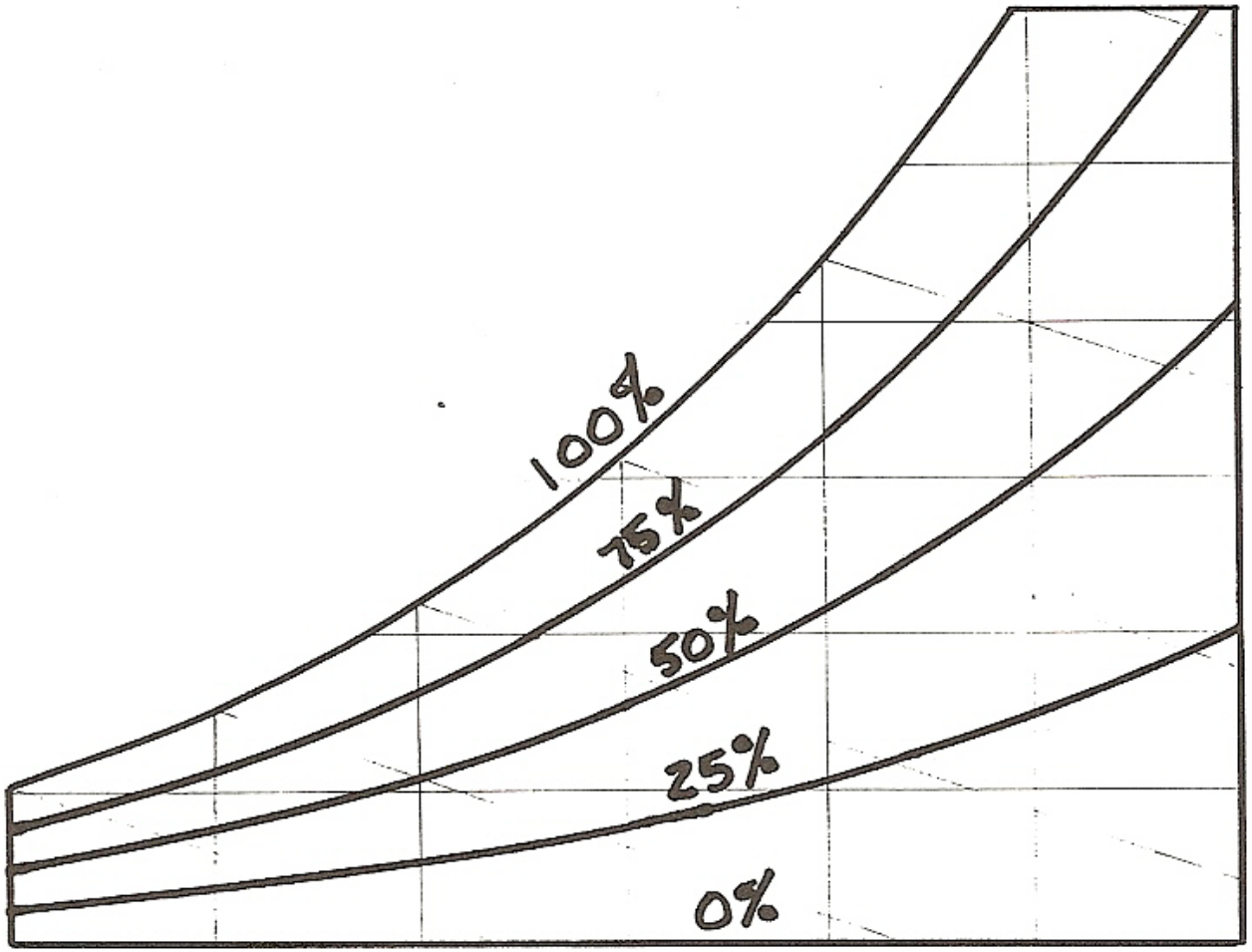


Figure 13-2 *Relative humidity isolines.*

Source: Gatley, Understanding Psychrometrics, Chapter 12

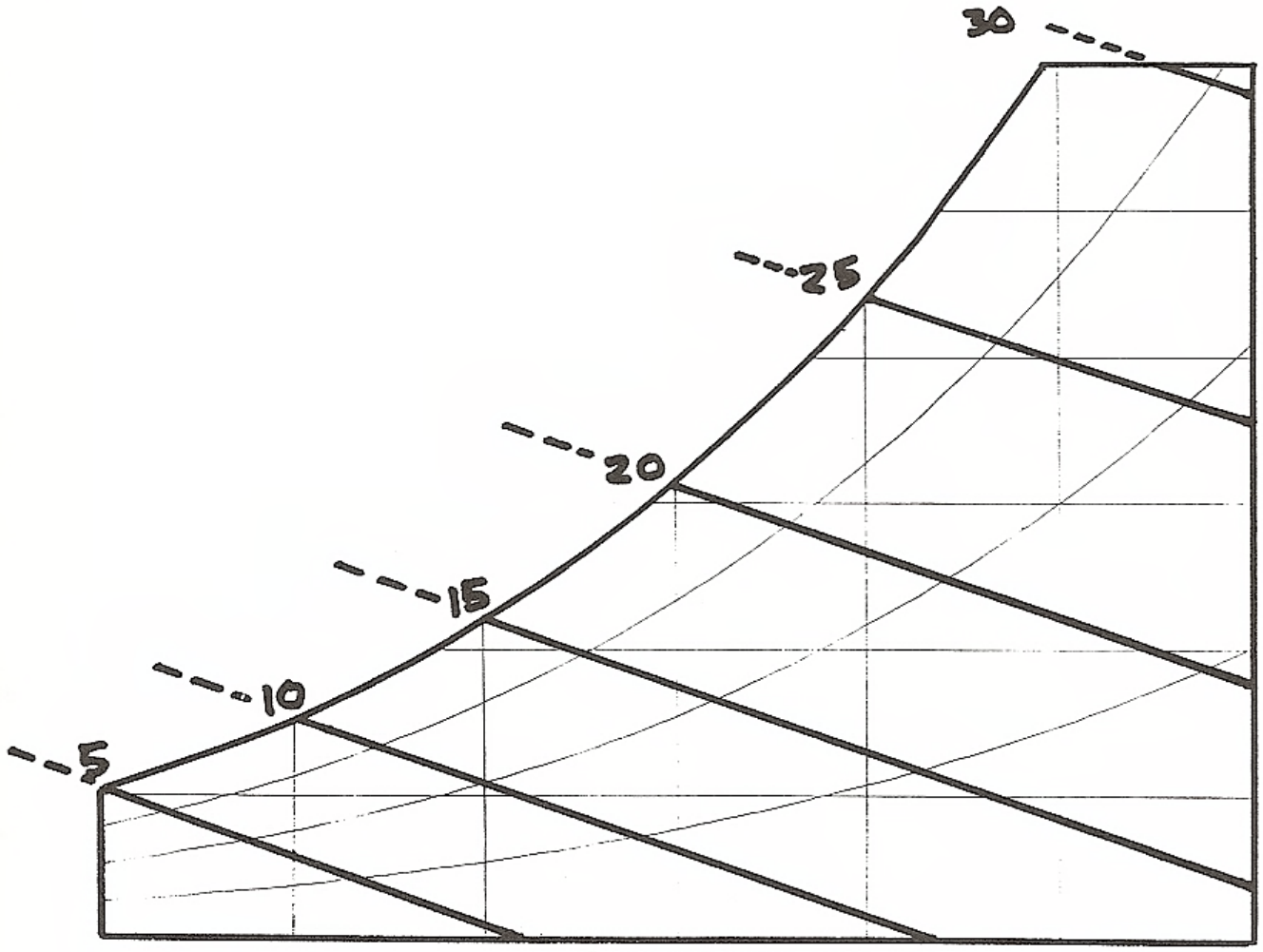


Figure 11-3 *Wet-bulb temperature isolines (t_{WB} in °C).*

Source: Gatley, Understanding Psychrometrics, Chapter 11

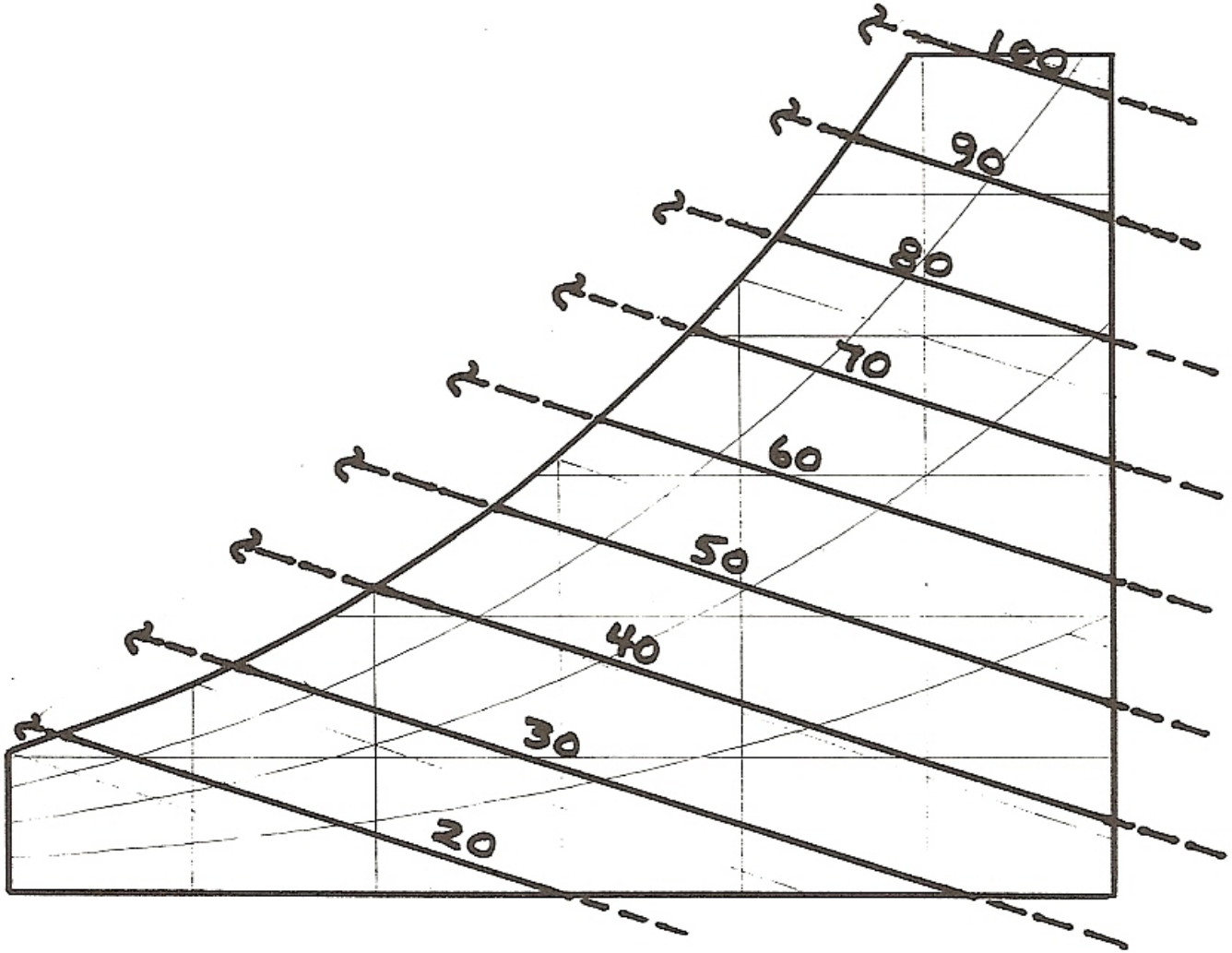


Figure 15-1 *Specific enthalpy isolines (h in units of kJ/kg$_{DA}$).*

Source: Gatley, Understanding Psychrometrics, Chapter 15

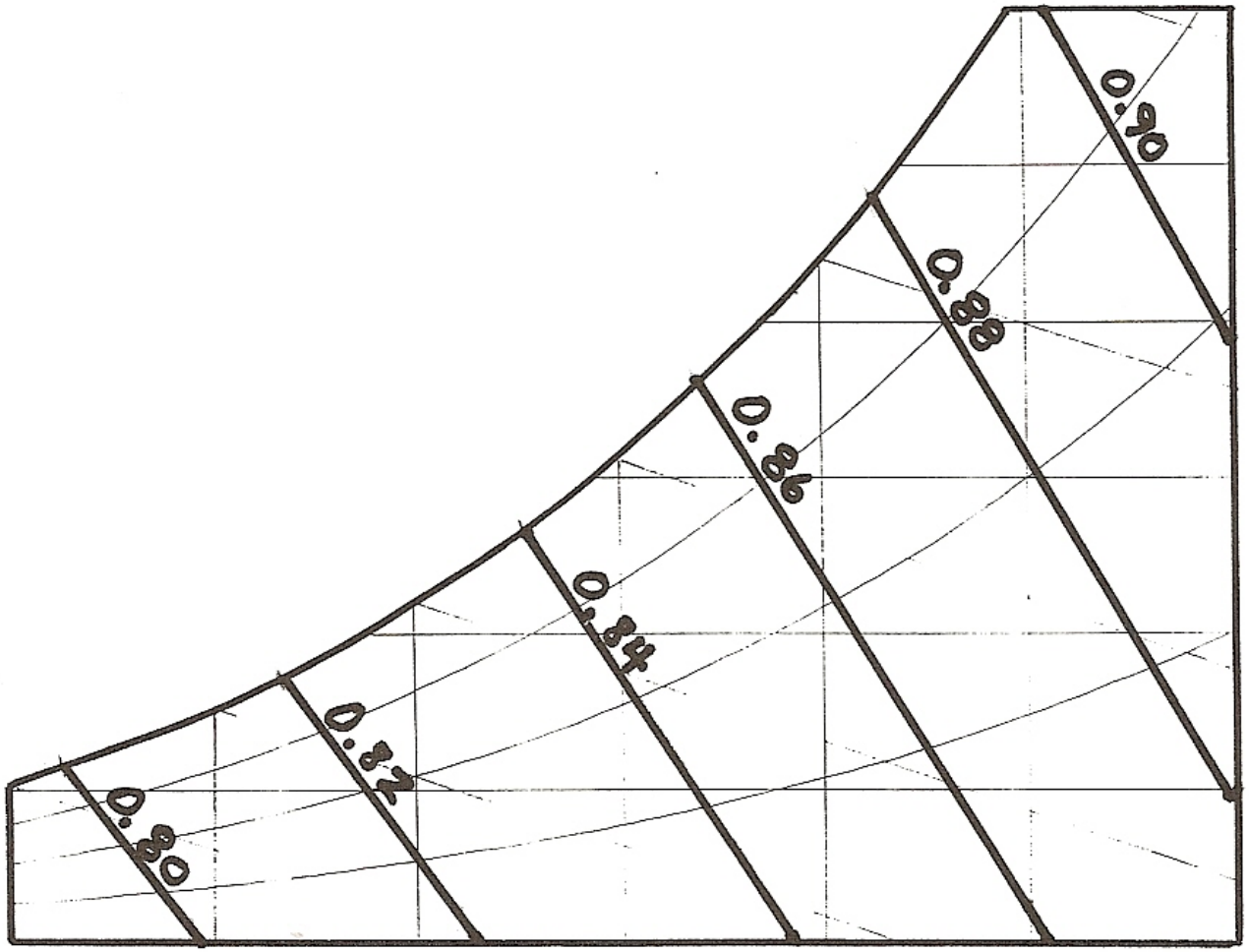


Figure 16-1 *Specific volume isolines (v in units of m^3/kg_{DA}).*

Source, Gatley, Understanding Psychrometrics, Chapter 16

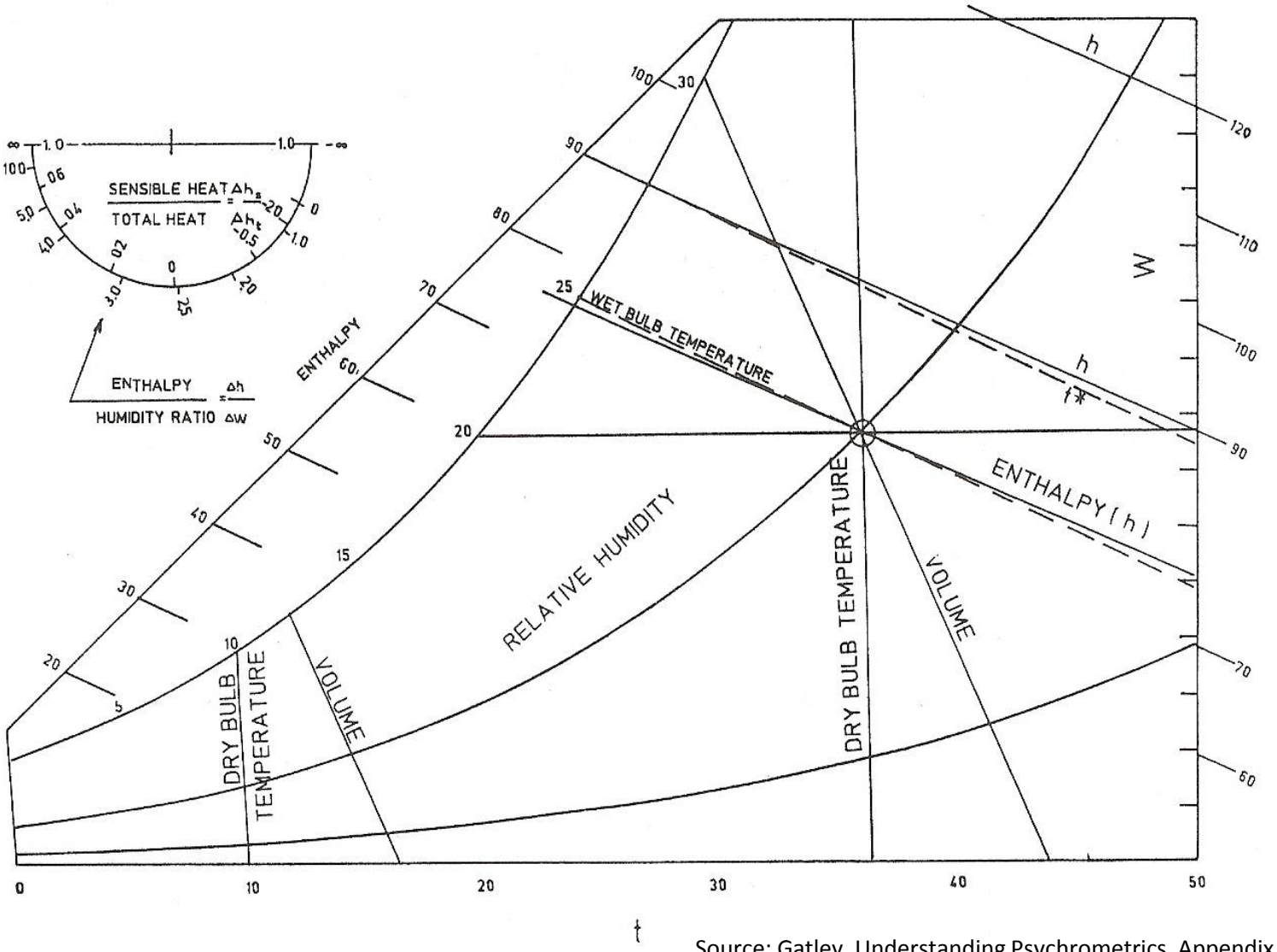


Figure A4-10 *Skeleton view of No. 1 SI—Normal Temperature—Sea Level.*

Source: Gatley, Understanding Psychrometrics, Appendix IV

Pyschrometrics

To find a “state point” you need to know three properties

- Pressure => usually barometric pressure
- Dry-bulb temperature
- A moisture property
  - wet-bulb temperature
  - relative humidity
  - dewpoint temperature

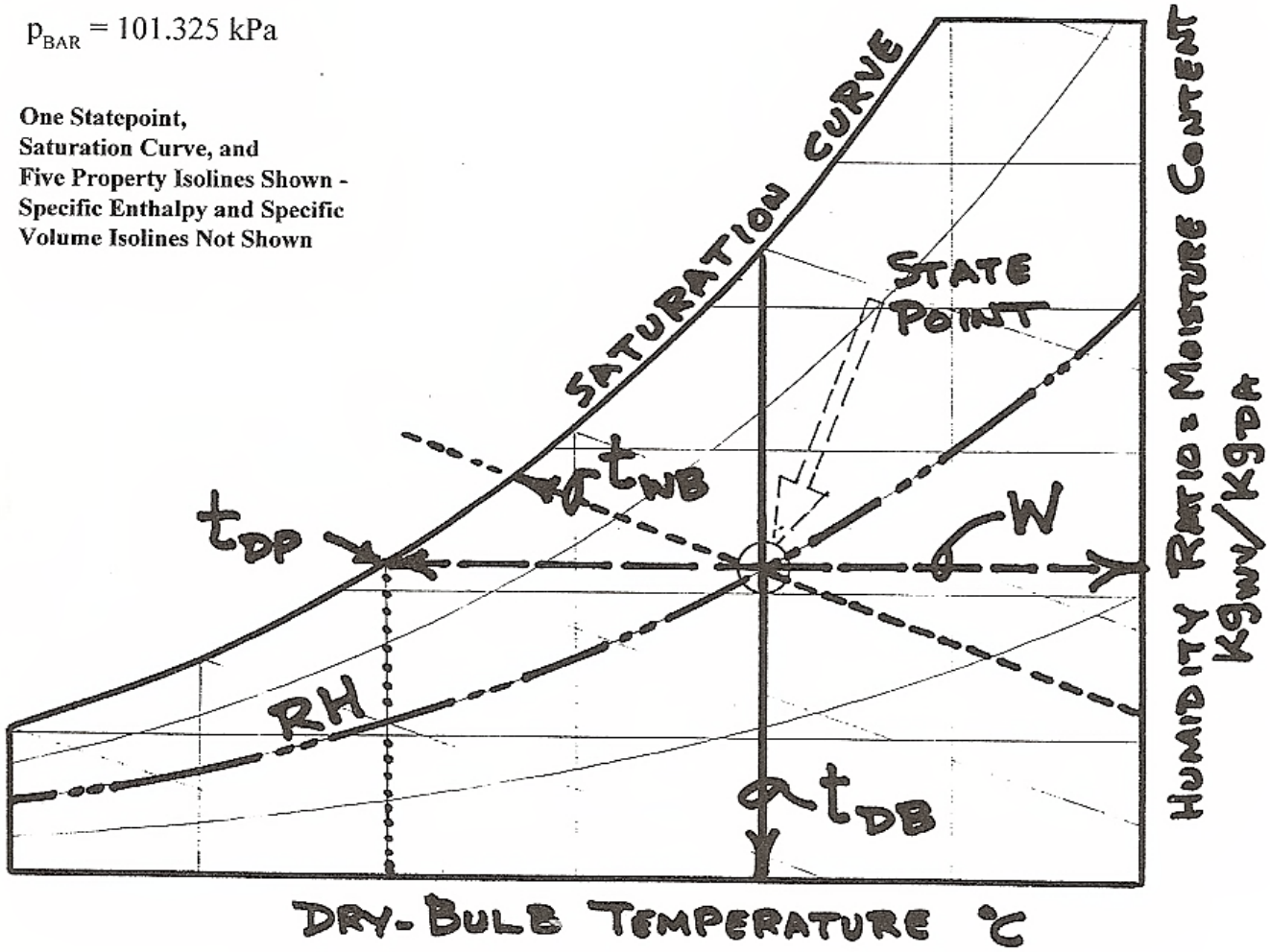


Figure 9-1 *Basic psychrometric chart.*

Source: Gatley, Understanding Psychrometrics, Chapter 9

Pyschrometrics

Four Basic Processes

- Sensible heating
- Sensible cooling
- Humidifying
- Dehumidifying only

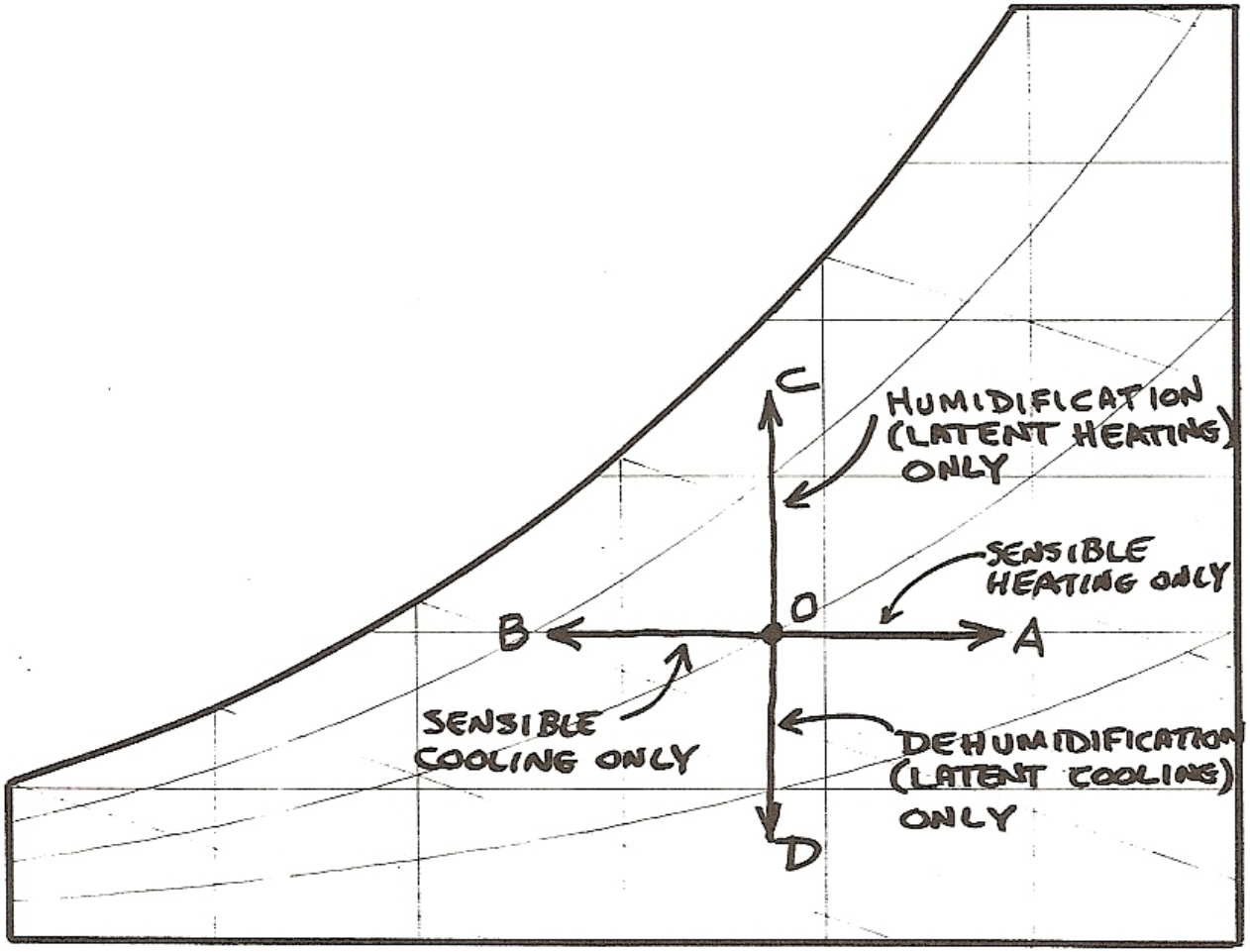


Figure 19-1 *Four basic processes.*

Source: Gatley, Understanding Psychrometrics, Chapter 19

Pyschrometrics

Other Common Processes

- Chemical dehumidifying
- Evaporative cooling
- Cooling and dehumidifying
- Heating and humidifying

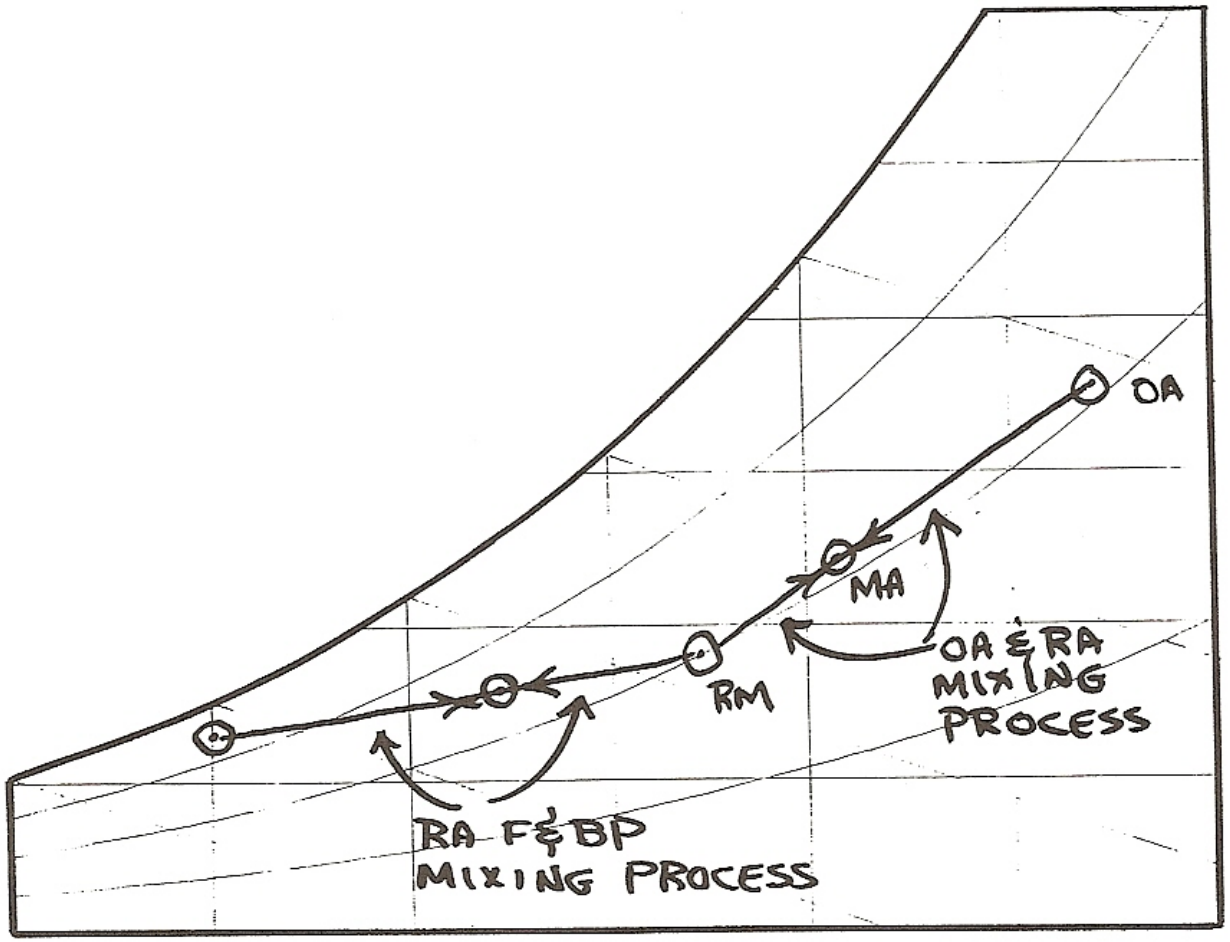


Figure 20-1 *Mixing processes.*

Source: Gatley, Understanding Psychrometrics, Chapter 20

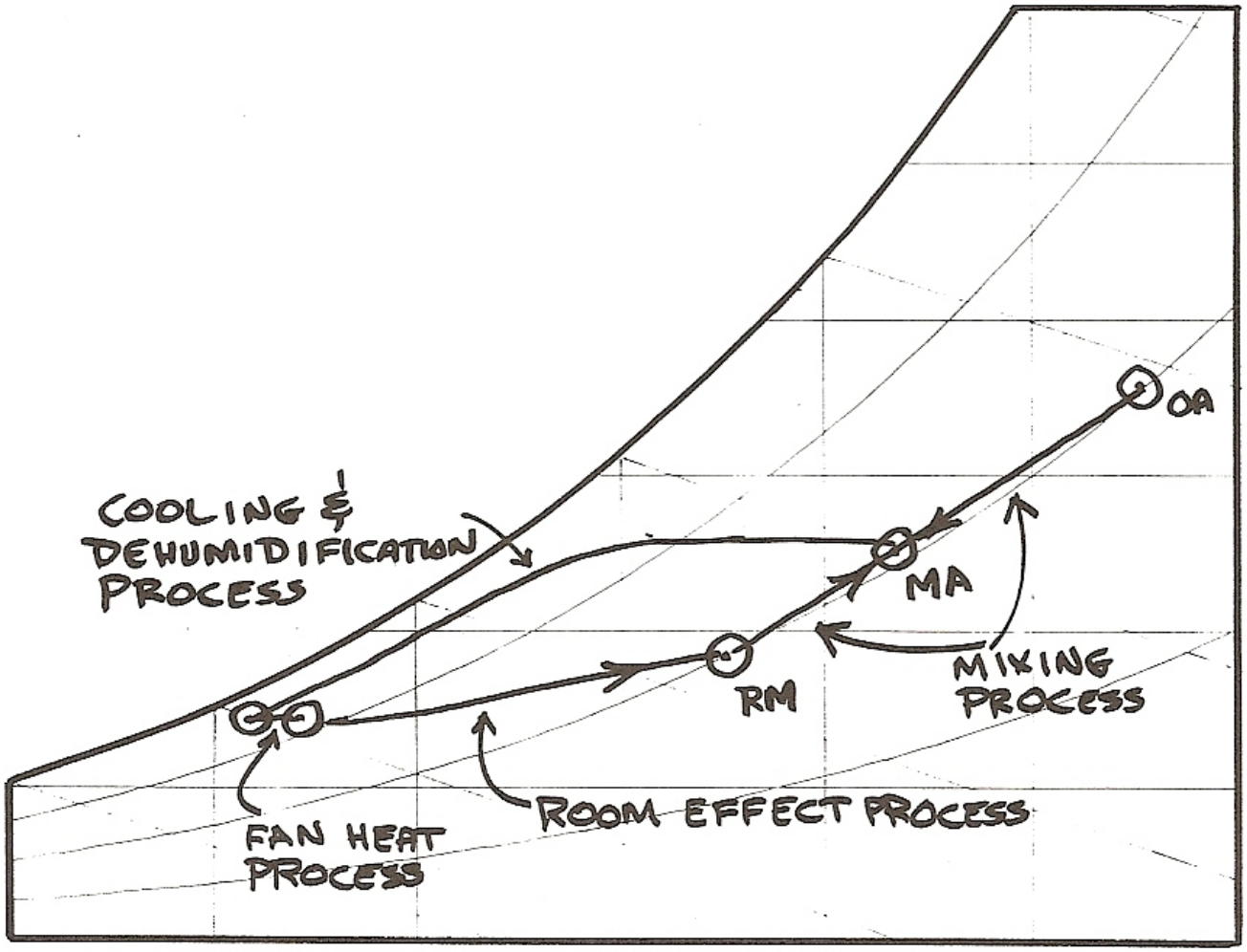
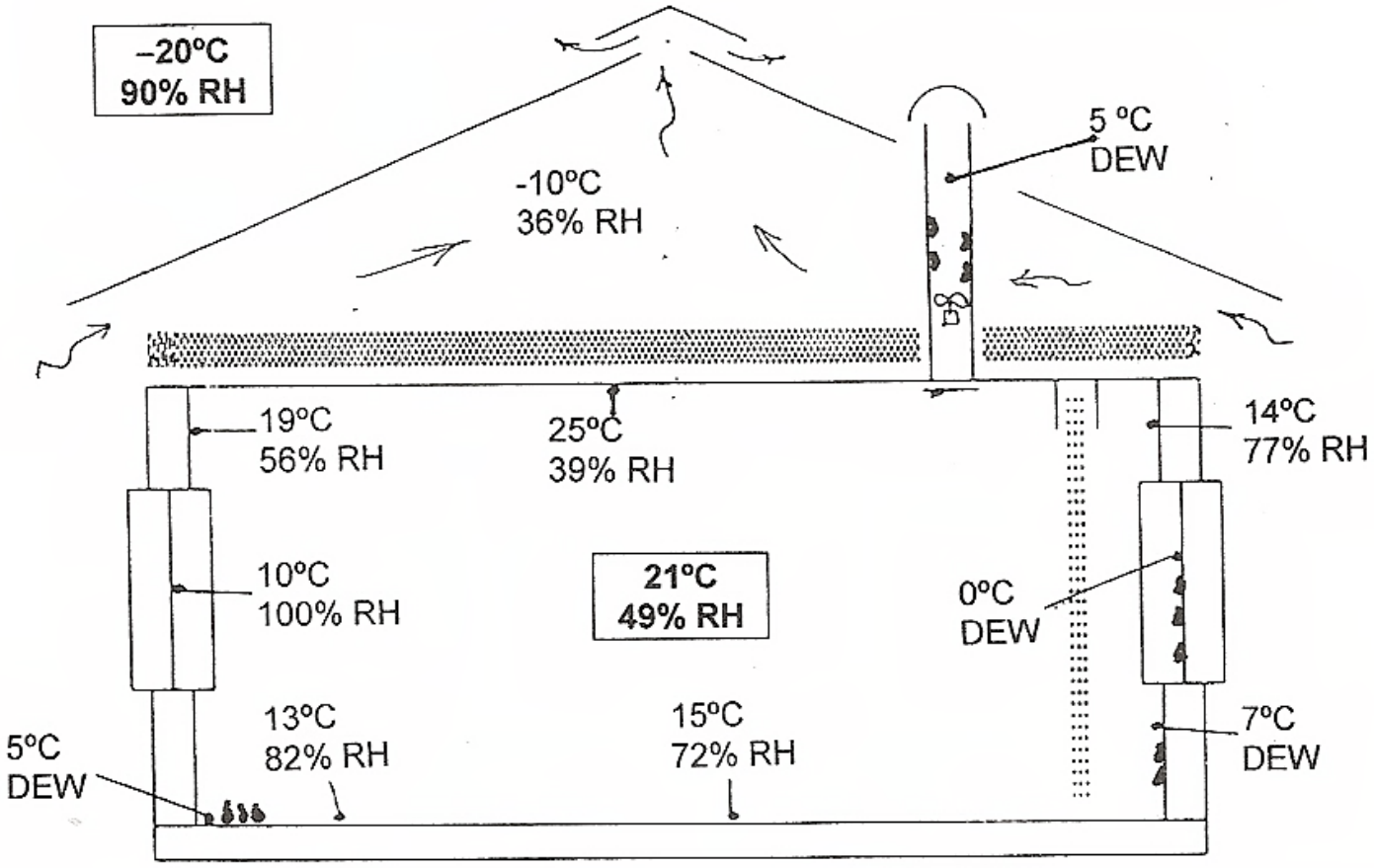


Figure 19-3 *A four-process air-conditioning cycle.*

Source: Gatley, Understanding Psychrometrics, Chapter 19



ROOM$_{CTR}$: 21°CDB, 10°CDP, 49% RH, p_{wv} 1228 Pa (0.3626 "H$_G$), W 0.00766 kg$_{WV}$ / kg$_{DA}$
OUTSIDE: -20°CDB, -21°CDP, 90% RH, p_{wv} 93 Pa (0.0275 "H$_G$), W 0.00058 kg$_{WV}$ / kg$_{DA}$

Figure 13-5 *Inside relative humidities in cold weather.*

Source: Gatley, Understanding Psychrometrics, Chapter 13

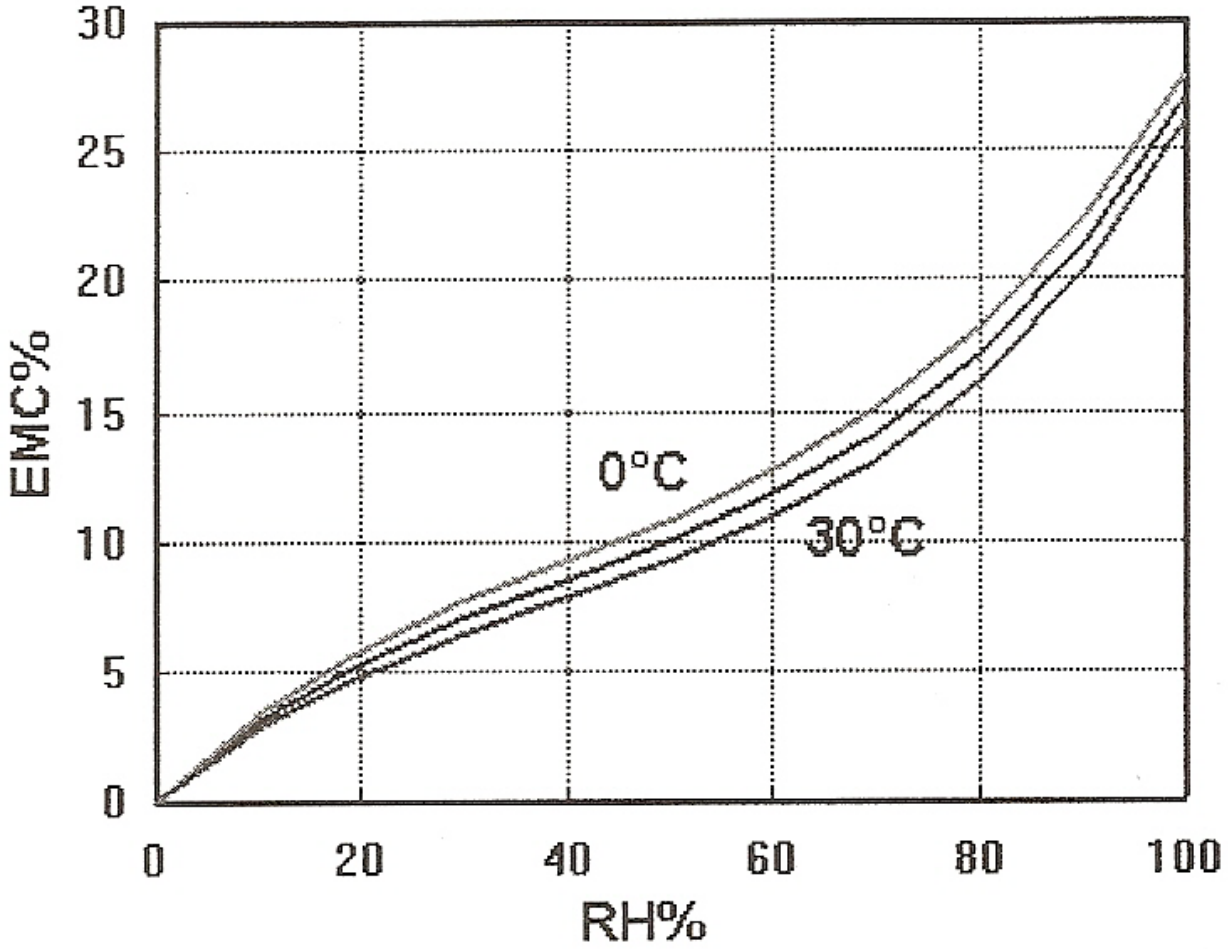


Figure 13-1 *Equilibrium moisture content of wood vs. relative humidity (by permission of Tim Padfield, Ph.D.; www.natmus.min.dk/cons/tp).*

Source: Gatley, Understanding Psychrometrics, Chapter 13

In Summary

Questions and Discussion

Next Class

- Moisture Transport & Control in Insulated Assemblies
  - General moisture concerns
  - Moisture in building materials
  - Moisture migration
  - Vapor diffusion vs. convective mass transport

- Readings
  - HF: Chapter 25 => 25.10 to 25.17
  - HF: Chapter 26 => 26.13 to 26.20
  - HF: Chapter 27 => 27.7 to 27.12
  - HPE: Chapter 3.5 & 3.6
  - BG: Pages 115 to 129 (Appendix II & III for editions prior to 2004)