Lecture Three

The psychrometry of Air Conditioning Processes:

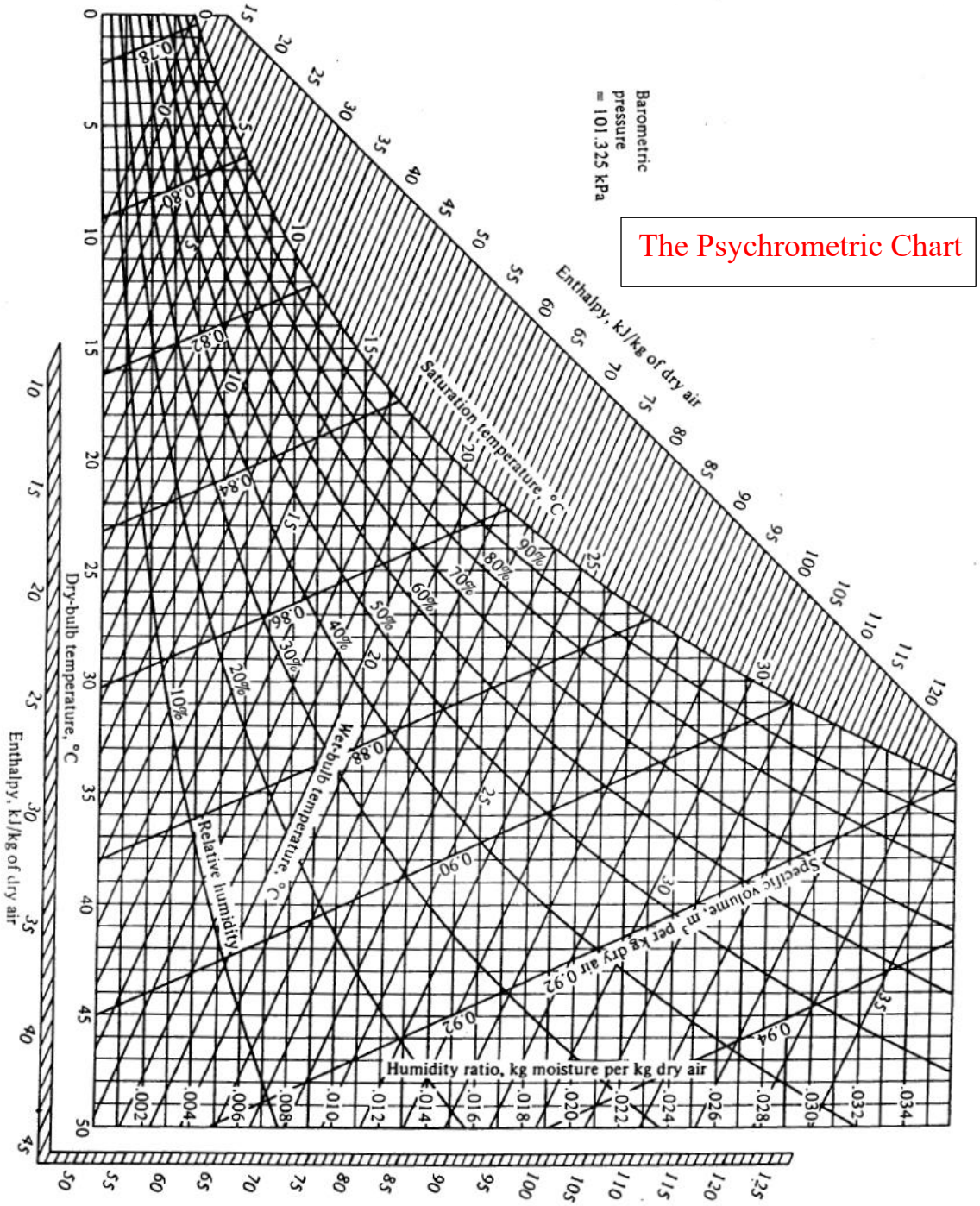
Although the equations that we have developed for the many properties of moist air are used for computer calculation. It is convenient to have the plotted in chart for easy reference during design HVAC system.

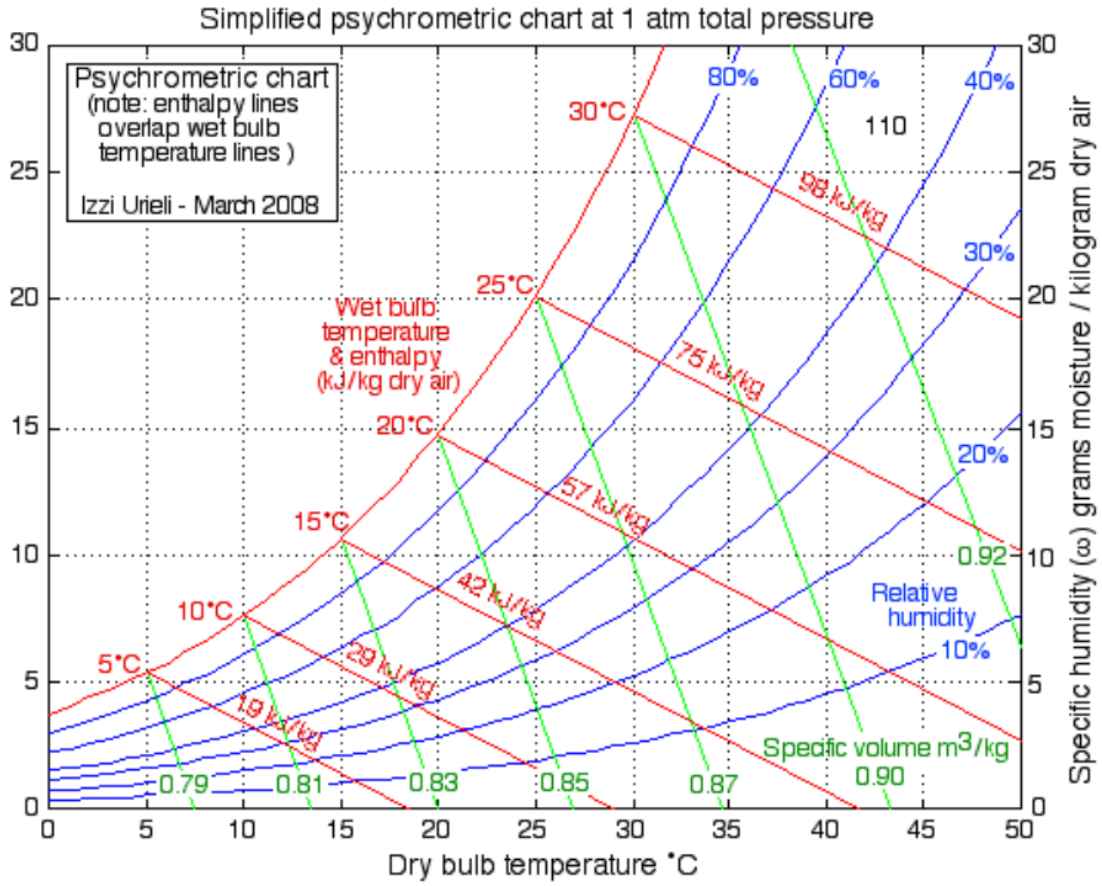
The psychrometric chart is an *x y* plot with dry bulb temperature as the abscissa and the moisture content as the ordinate. Since these are two independent thermodynamics variable, all other properties of moist air can be expressed as function of them at a given atmospheric.

1- The psychrometry chart contains all the parameters of the air-water vapour mixture. Namely, d.b., w.b., dew point temperature, specific humidity (w), enthalpy (h), relative humidity (r.h), specific volume (υ), and sensible heat ratio (SHR) scale.

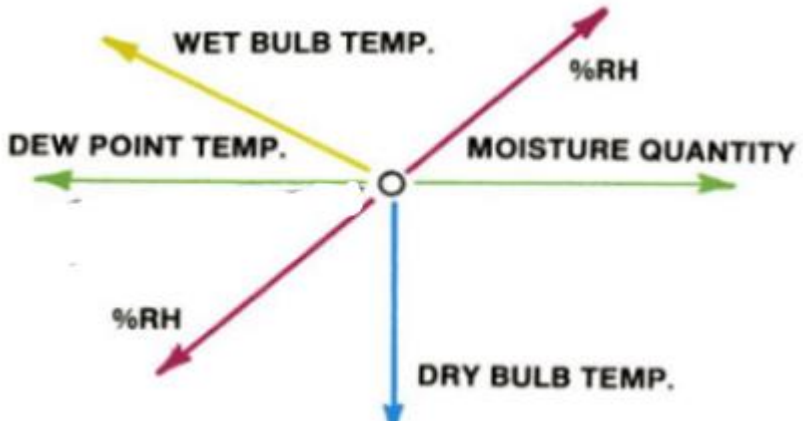
All the above properties can be found for any state point. A state point is fixed by any two properties.

The Psychrometric Chart

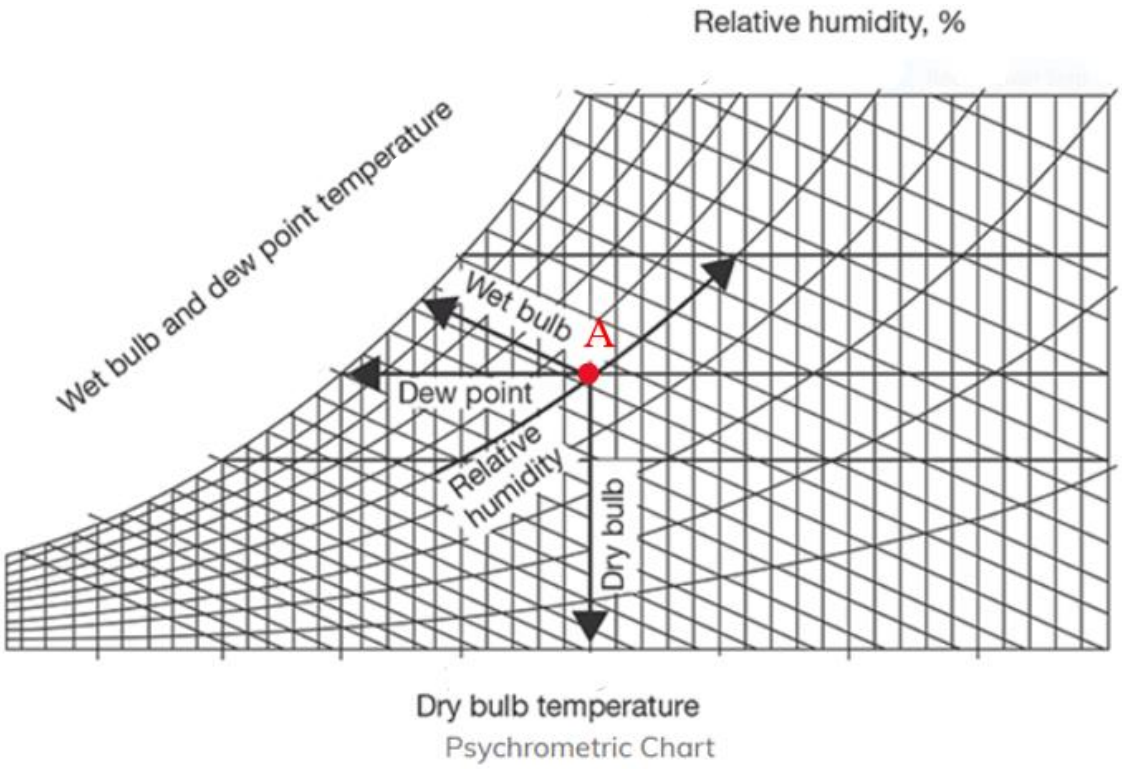




How to use the psychrometric chart



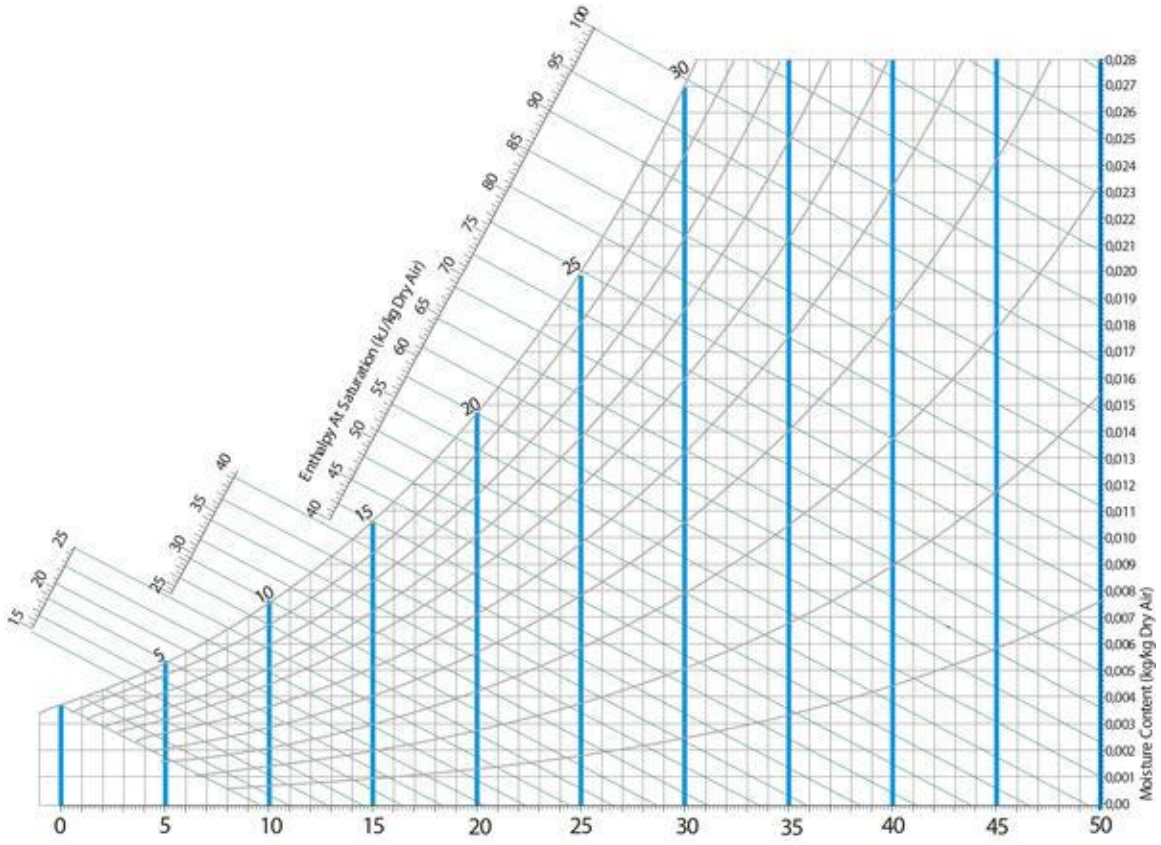
Sketch below show how to find (relative humidity (dry bulb, wet bulb & dew point temperatures) for a state point (A).



Figures below shows how line of constant properties listed appear on the psychrometric chart.

Dry bulb temperatures:

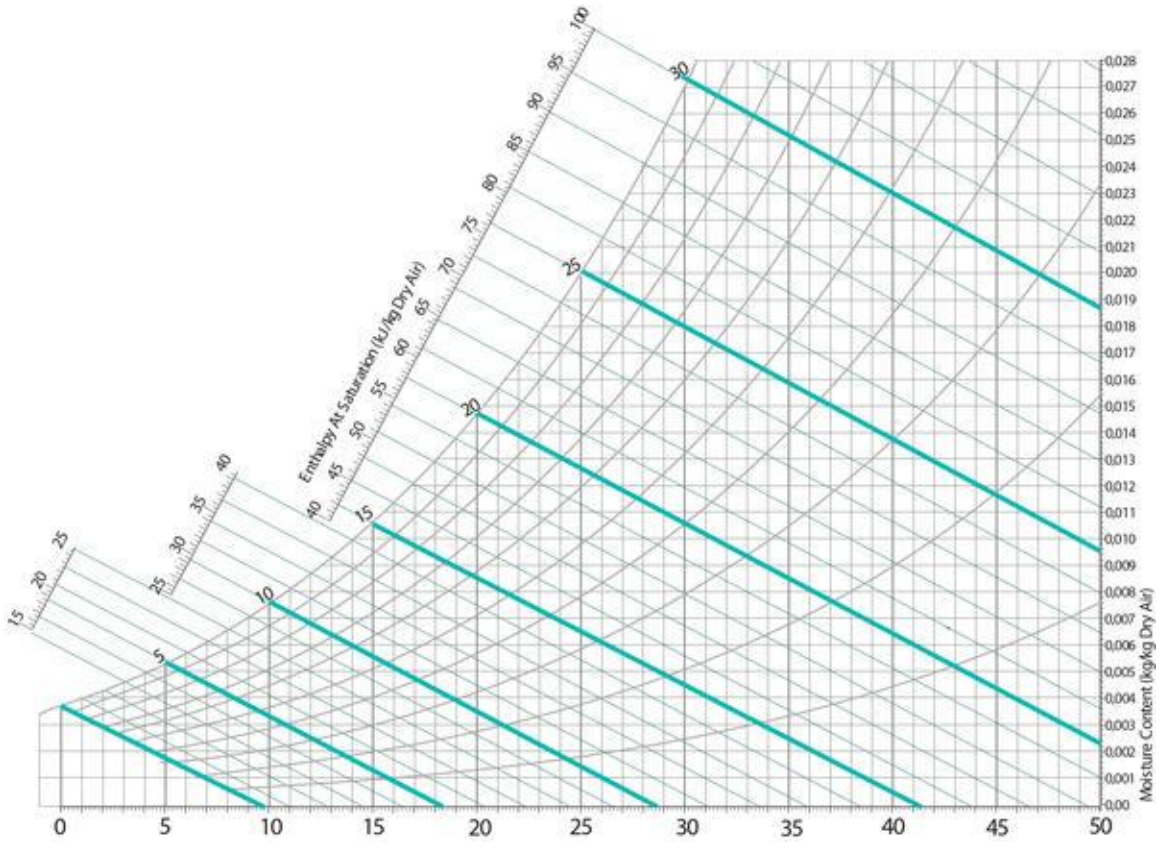
Every psychrometric chart includes vertical lines that represent the dry bulb temperatures. Air temperature increases from left to right.



Dry bulb temperature lines on a psychrometric chart

Wet bulb temperatures and enthalpies:

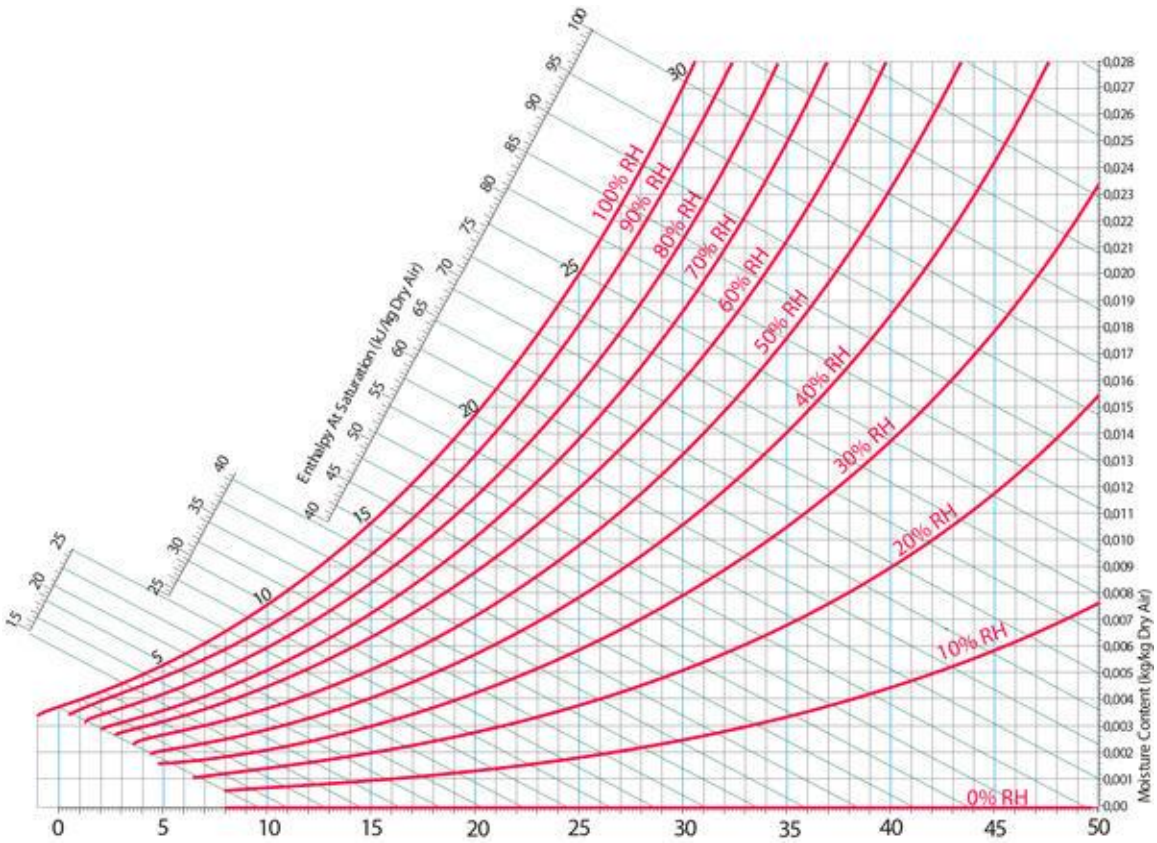
Every psychrometric chart also includes wet bulb temperatures and enthalpies. These lines are indicated at diagonals, and like dry bulb temperatures they increase from left to right.



Wet bulb temperature & enthalpy lines (on a psychrometric chart

Relative humidity:

Another feature indicated on every psychrometric chart is relative humidity lines. These lines are curved and begin at 100% along the top of the chart and decrease moving downward. It is fairly common for these lines to be indicated in intervals of ten.



Relative humidity lines on a psychrometric chart

Specific humidity and enthalpy (mass and energy) are the basic properties to construct the psychrometric chart.

Dry bulb temperature is shown along the horizontal axis. When you draw lines through a chart along which the quantity under consideration remains the same, they're called isolines.

Lines of constant dry bulb temperature are straight but divergent.

Coordinates of dry bulb & (w) are not rectangular but oblique to make dry bulb dry bulb lines vertical.

Specific humidity (w) lines are parallel, also the enthalpy lines are parallel and equally spaced.

Lines of wet bulb temperature and specific volume are slightly curved and divergent.

e.g: Air at 30°C d.b. & 25°C w.b. enters a cooling and dehumidifying coil at a rate of $3m^3$/sec. and leaves as saturated air at 15°C. Find:

a) all the properties of entering and leaving air. b) the heat transfer rate of the coil. c) the rate of moisture removal.

Sol: a) at point (1) h_1=76kJ/kg dry air. at point (2) h_2=42kJ/kg dry air.

W_1=0.018kg/kg dry air. W_2=0.0107kg/kg dry air.

υ_1=0.882m^3/kg. υ_2=0.831m^3/kg.

ϕ_1=66% ϕ_2=100%.

d.p.)$_1$=23.2°C d.p.)$_2$=15°C

b) Rate of heat transfer =$\dot{m}(h_1-h_2)$, $\dot{m}=\dot{\upsilon}.d=\frac{\dot{\upsilon}}{\upsilon}=\frac{3}{0.882}=3.401$kg/sec.

rate of heat transfer= 3.401(76-42)=115.65kJ/sec.

c) Rate of moisture removal=$\dot{m}(w_1-w_2)$=3.401(0.018-0.0107)=0.0248kg/sec.