

ABE 201

Biological Thermodynamics 1

Module 14

Psychrometrics

Overview

- What is psychrometry?
- Elements of the psychrometric chart
- How to read a psychrometric chart
- Applications in mass and energy balance problems

Psychrometry

- The measurement (μέτρον) of cold (ψυχρόν) gas-vapor mixtures.
- Most commonly, the gas is air and the vapor is water.
- In practice, psychrometry relates measurable properties of air/water mixtures to thermodynamic state properties

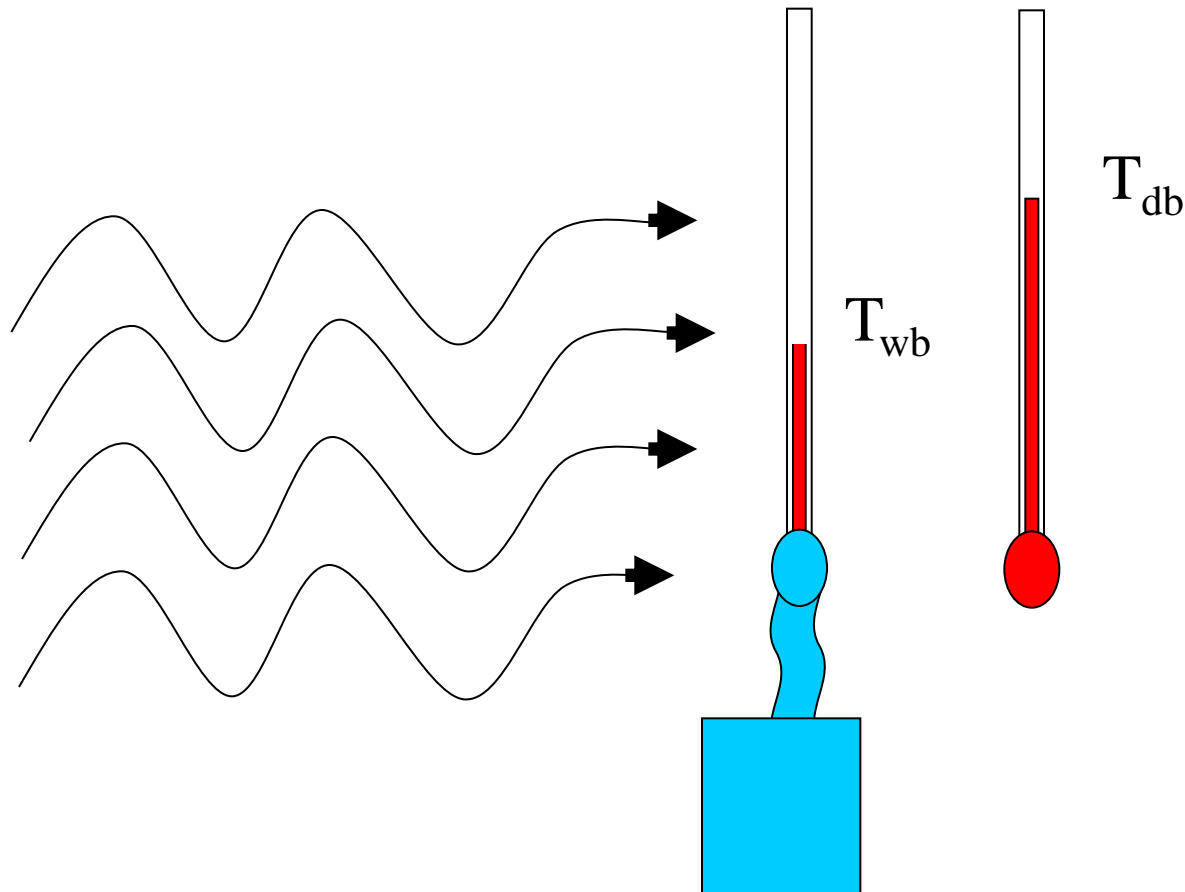
Psychrometric Measurements

- Dry-Bulb Temperature, T or T_{db} = air temperature as measured by thermometer (or equivalent)
- Wet-Bulb Temperature, T_{wb} = temperature of air after undergoing evaporative cooling
- Dew Point, T_{dp} = temperature at which humid air becomes saturated (constant pressure)

State Properties

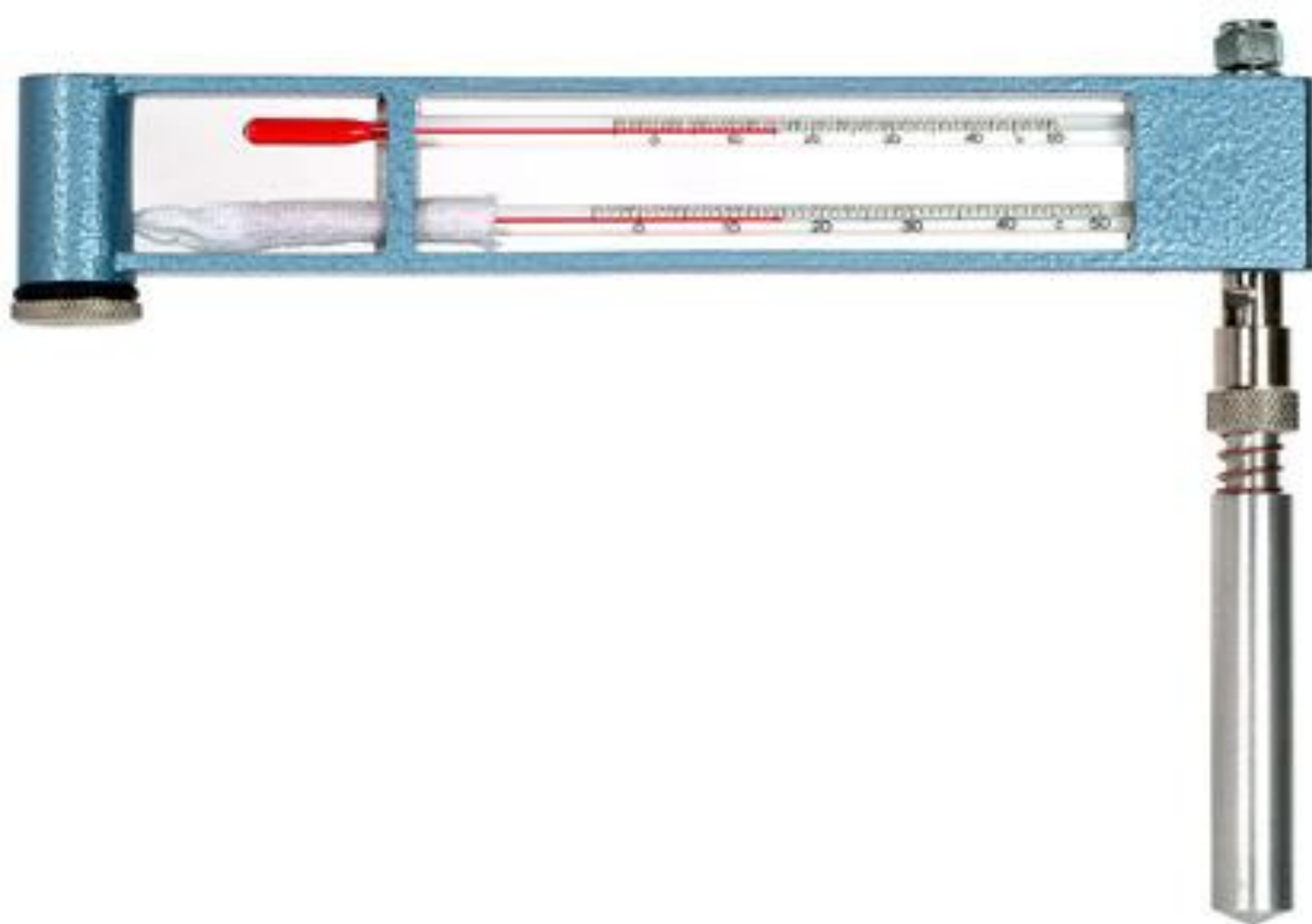
- Specific Volume, \hat{V} = the specific volume of DA (minus volume of water vapor)
- Specific Enthalpy, \hat{H} = the enthalpy of the dry air
- Absolute Humidity, h_a = the ratio of water vapor to dry air (DA), aka moisture content
- Relative Humidity, $h_r = 100\% * p_{H_2O} / p_{H_2O}^*$

Wet-Bulb Temperature, T_{wb}



Wet-Bulb Temperature, T_{wb}

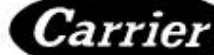
- Evaporation of the water from the wick cools the thermometer bulb
- Wet-bulb temperature is a function of:
 - Dry-bulb temperature
 - Moisture content of air
- If the air is saturated (100% rel. hum.), no water evaporates and $T_{wb} = T_{db}$





Psychrometric Chart

- aka humidity chart
- Air – Water systems at 1 atm
- Approximate values without a lot of calculations
- Shows relationships between physical and thermodynamic properties
- Useful for determining changes in temperature, pressure, and humidity
- Analysis of humidification, drying, air-conditioning processes (HVAC)



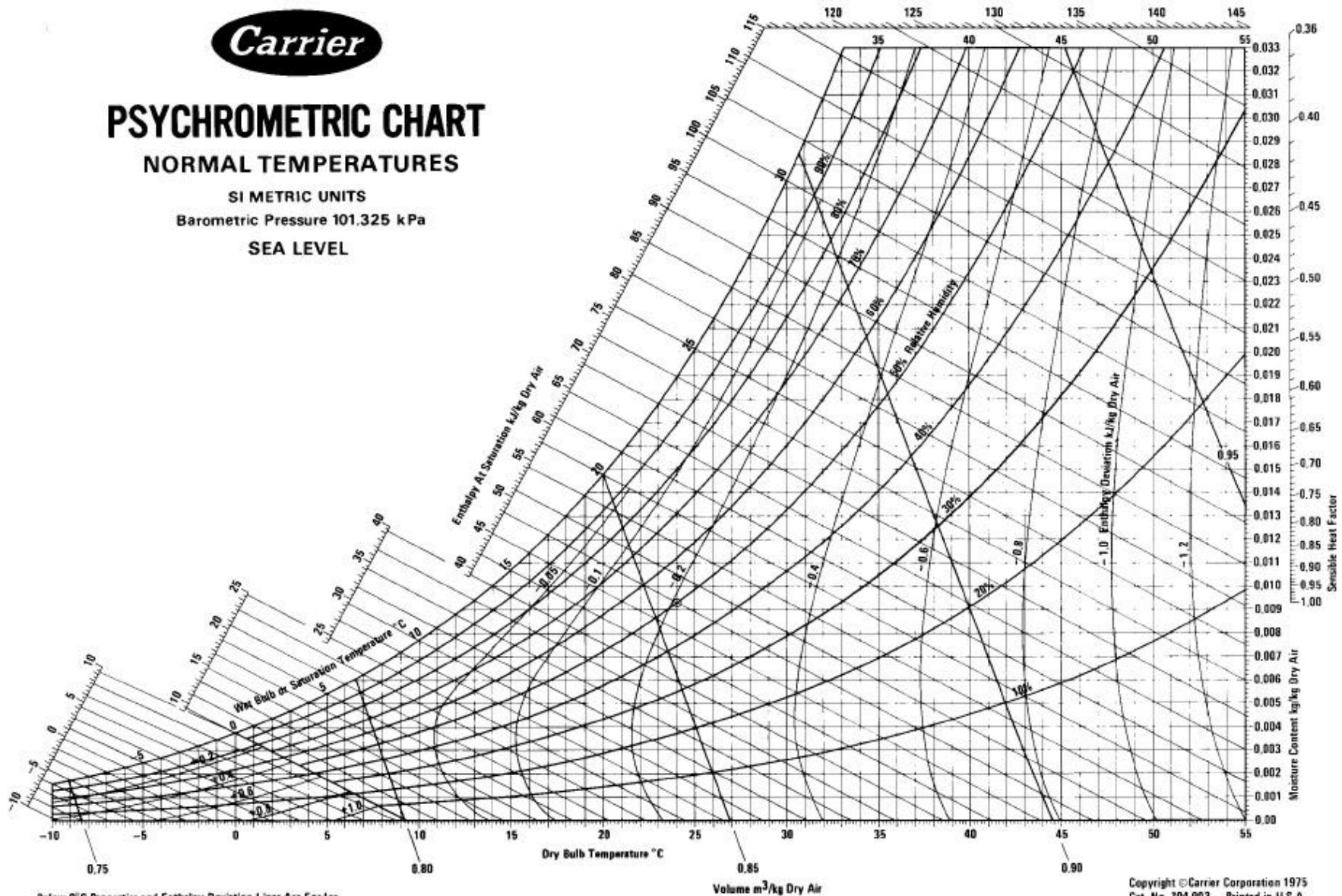
PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS

Barometric Pressure 101.325 kPa

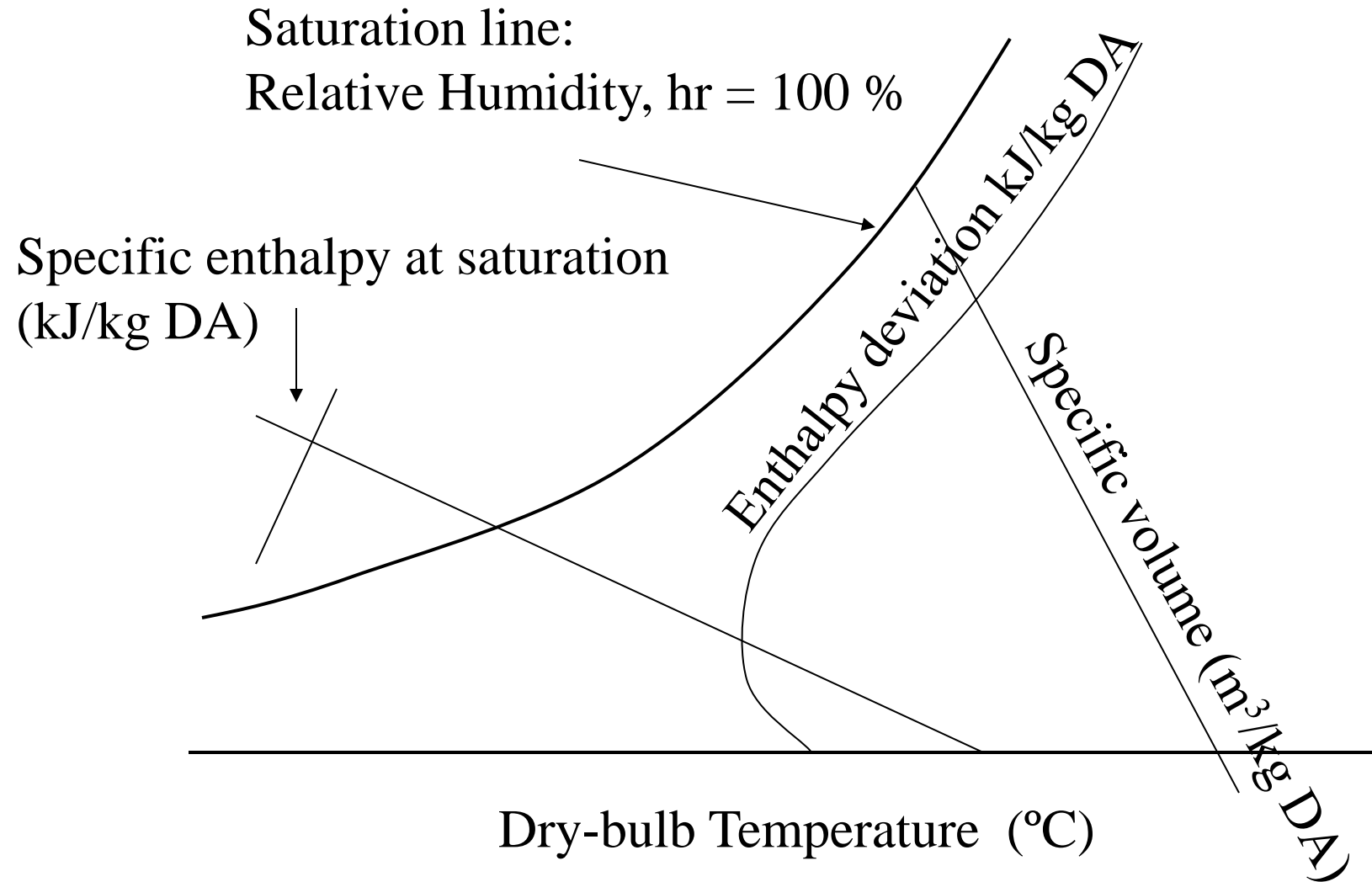
SEA LEVEL



Below 0°C Properties and Enthalpy Deviation Lines Are For Ice

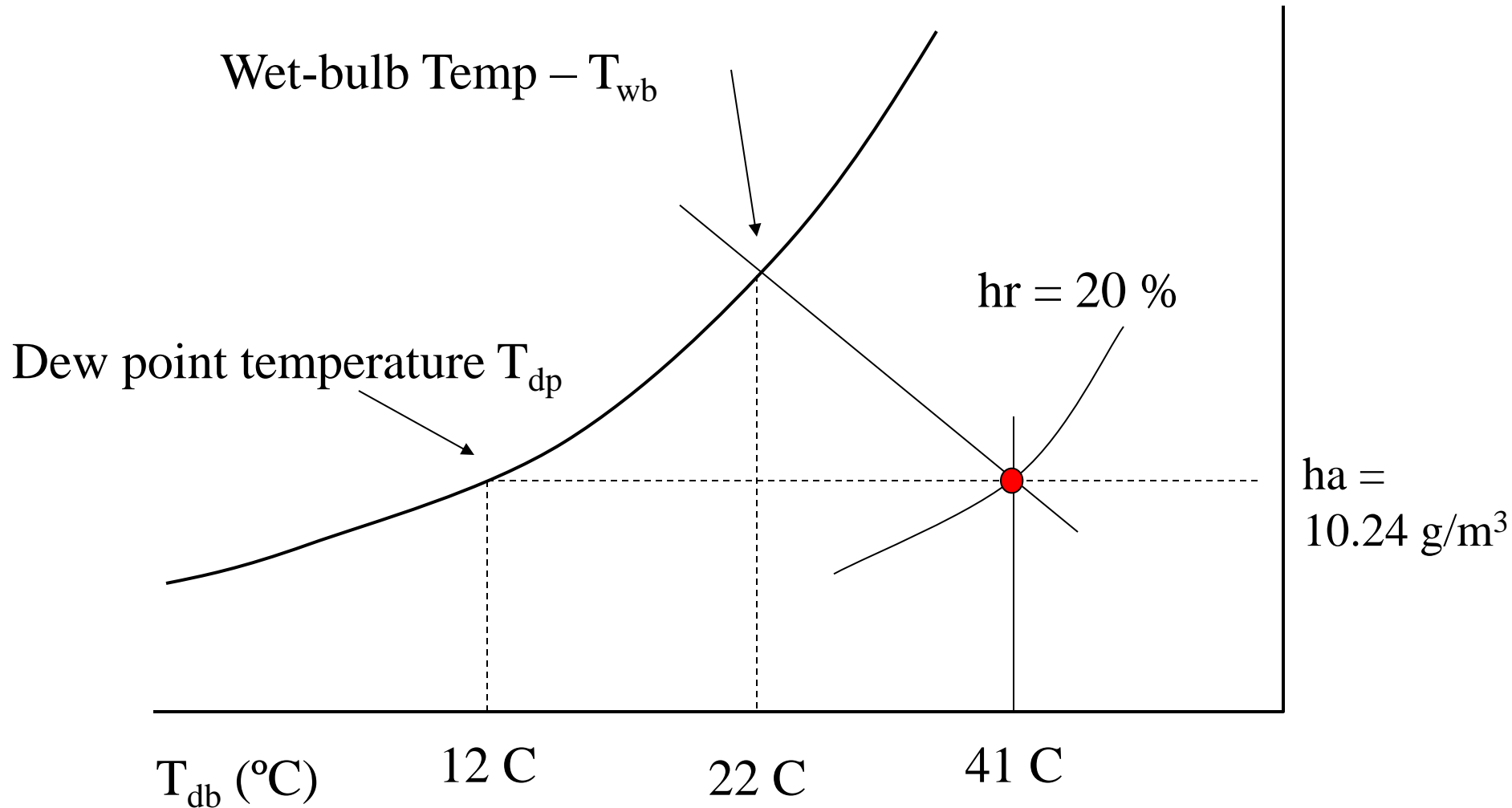
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Basic Components of the chart

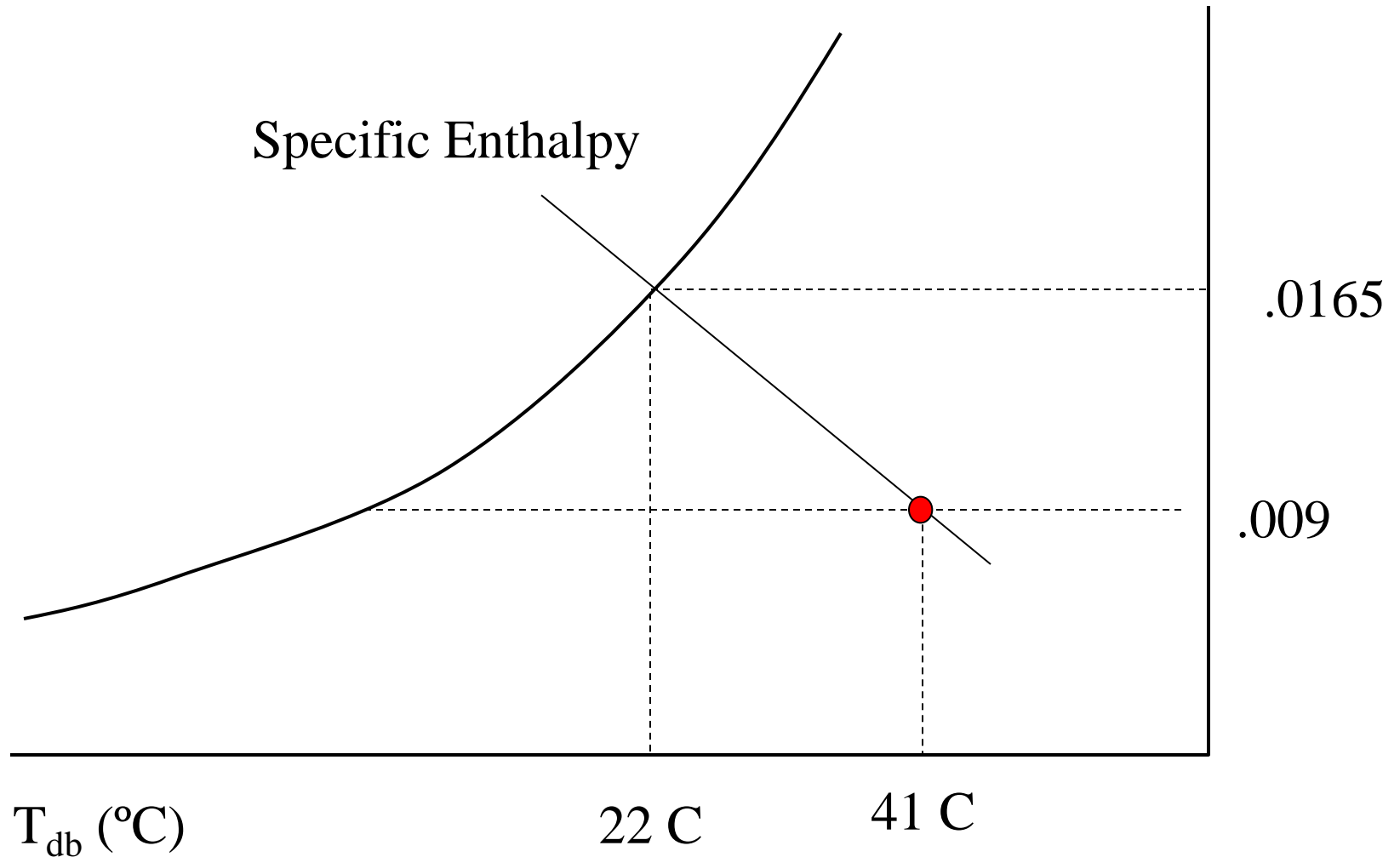


Absolute humidity: h_a (mass $H_2O(v)$ /mass Dry Air)

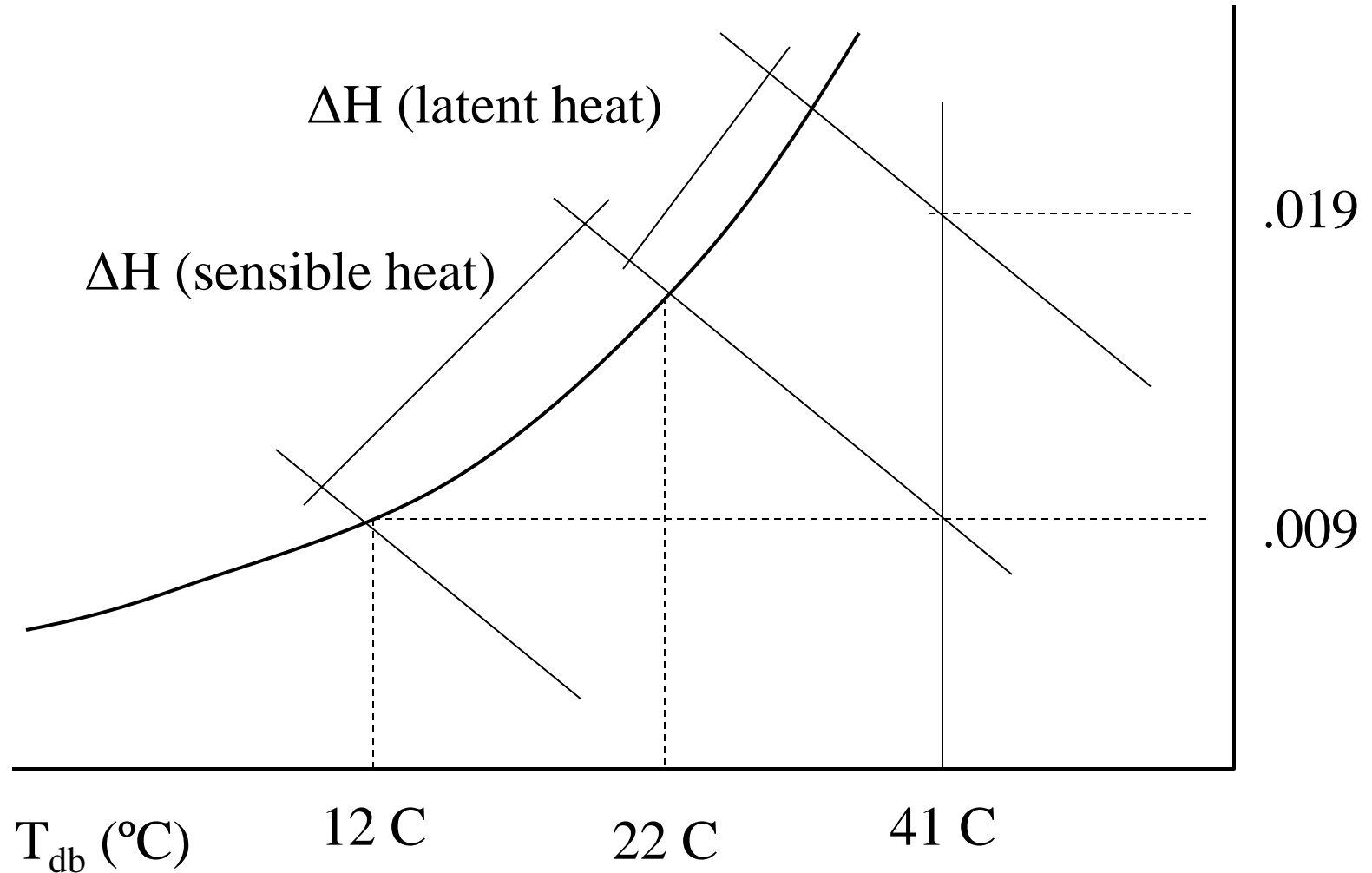
More information on the chart!



Adiabatic Cooling (aka Evaporative Cooling)



Energy Changes on the chart



Online Psychrometric Calculators

<http://linricsoftw.web701.discountasp.net/webpsycalc.aspx>

<http://www.sugartech.co.za/psychro/>

PsyCalc[®]

Switch to IP

41 °Cdb ▼

20 %RH ▼

0 Alt in m ▼

41.00	°Cdb
22.64	°Cwb
20.00	%RH
9.754	g/kg
13.60	°Cdp
66.26	kJ/kg
0.9039	m³/kg
11.69	mm Hg VP
1.116	kg/m³
10.24	g/m³

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psychrometric
calculations!*

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Psychrometric Calculations

The formulations used here to calculate moist air properties are based on perfect gas relations published in 1989 [ASHRAE](#) Fundamentals. We strongly recommend that you to compare the results calculated by this worksheet with a psychrometric chart. There is **no error** in the calculations.

Inputs

Unit Chosen:	<input checked="" type="radio"/> SI	<input type="radio"/> IP
Parameter Name	Value	Unit
Dry Bulb Temp.:	<input type="text" value="41"/>	<input type="text" value="C"/>
Wet Bulb Temp.:	<input type="text" value="22.46673779"/>	<input type="text" value="C"/>
Relat. Humidity:	<input checked="" type="radio"/> 20	<input type="text" value="%"/>
Dew Point Temp	<input type="text" value="13.62967351"/>	<input type="text" value="C"/>
Altitude	<input type="text" value="0.0"/>	<input type="text" value="m"/>

Outputs

Atmospheric Press	<input type="text" value="1.013238759"/>	<input type="text" value="bar"/>
Sat. Vapor Press.	<input type="text" value="77.86281067"/>	<input type="text" value="mbar"/>
Partial Vapor Press.	<input type="text" value="15.57256213"/>	<input type="text" value="mbar"/>
Humidity Ratio	<input type="text" value="0.009708792"/>	<input type="text" value="kg/kg"/>
Enthalpy	<input type="text" value="66.21246992"/>	<input type="text" value="kJ/kg"/>
Specific Volume	<input type="text" value="0.902553601"/>	<input type="text" value="m3/kg"/>

Expert Engineering Advice

You may want some expert engineering advice on [Spray Ponds](#) or on [Cooling Towers](#), if so please feel free to [contact](#) us.

Summary

- Psychrometric charts illustrate graphically the relationship between thermodynamic properties of air-water vapor mixtures.
- Much like steam tables, compressibility charts, and the Antoine equation, these charts can be used to solve mass/energy balances where water/air are involved.