Topic 3.3. Humidity Psychrometric Chart

Last lecture

- ✓ Basic concepts and terminology related to humidity

This lecture

- ✓ Psychrometric (humidity) terminology
- ✓ Plot processes on a psychrometric chart and analyze processes

Part of this lecture is obtained from notes of professor Zayed Hamamreh – ChE – University of Jordan

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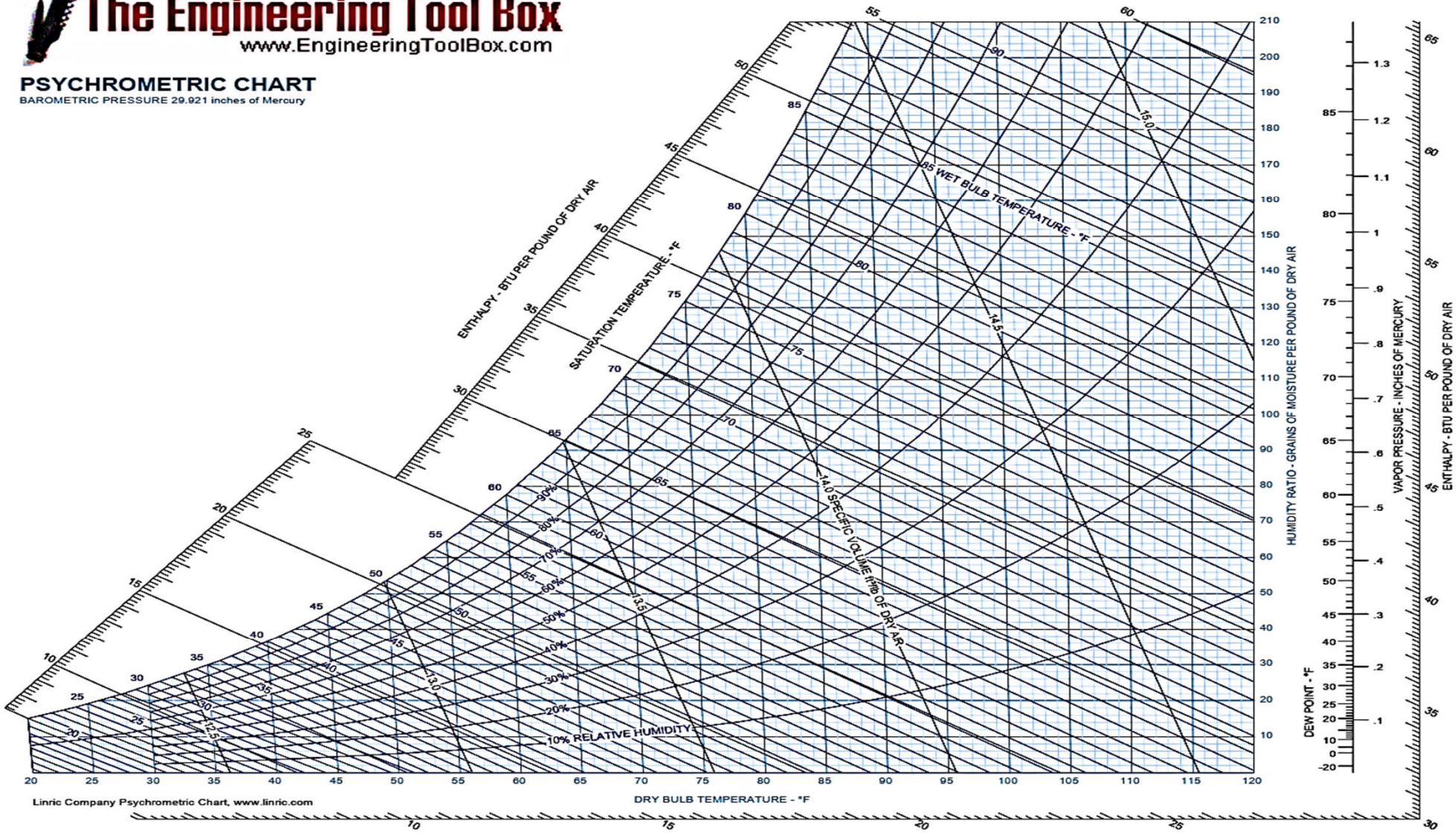
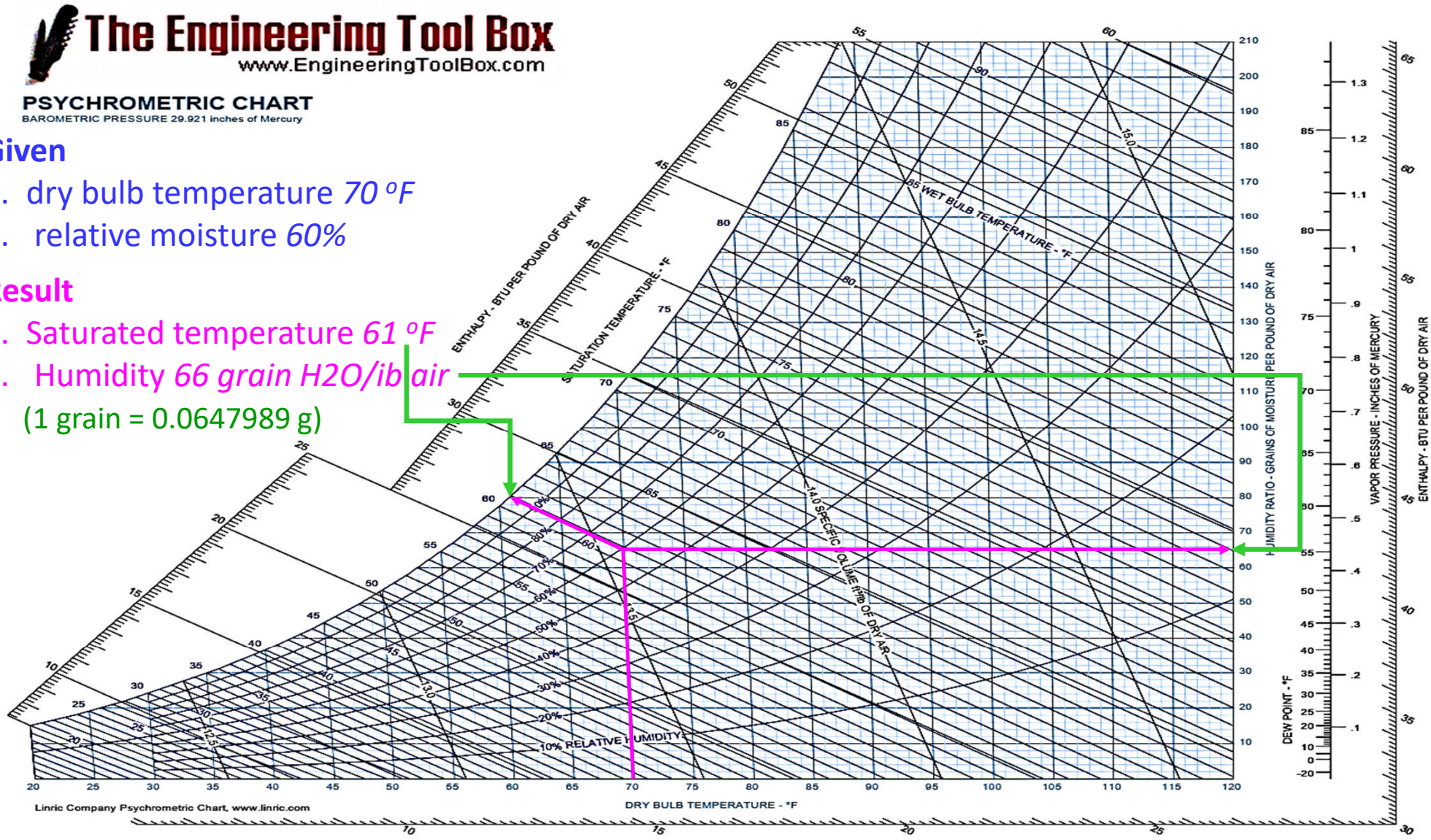
PSYCHROMETRIC CHART

BAROMETRIC PRESSURE 29.921 inches of Mercury

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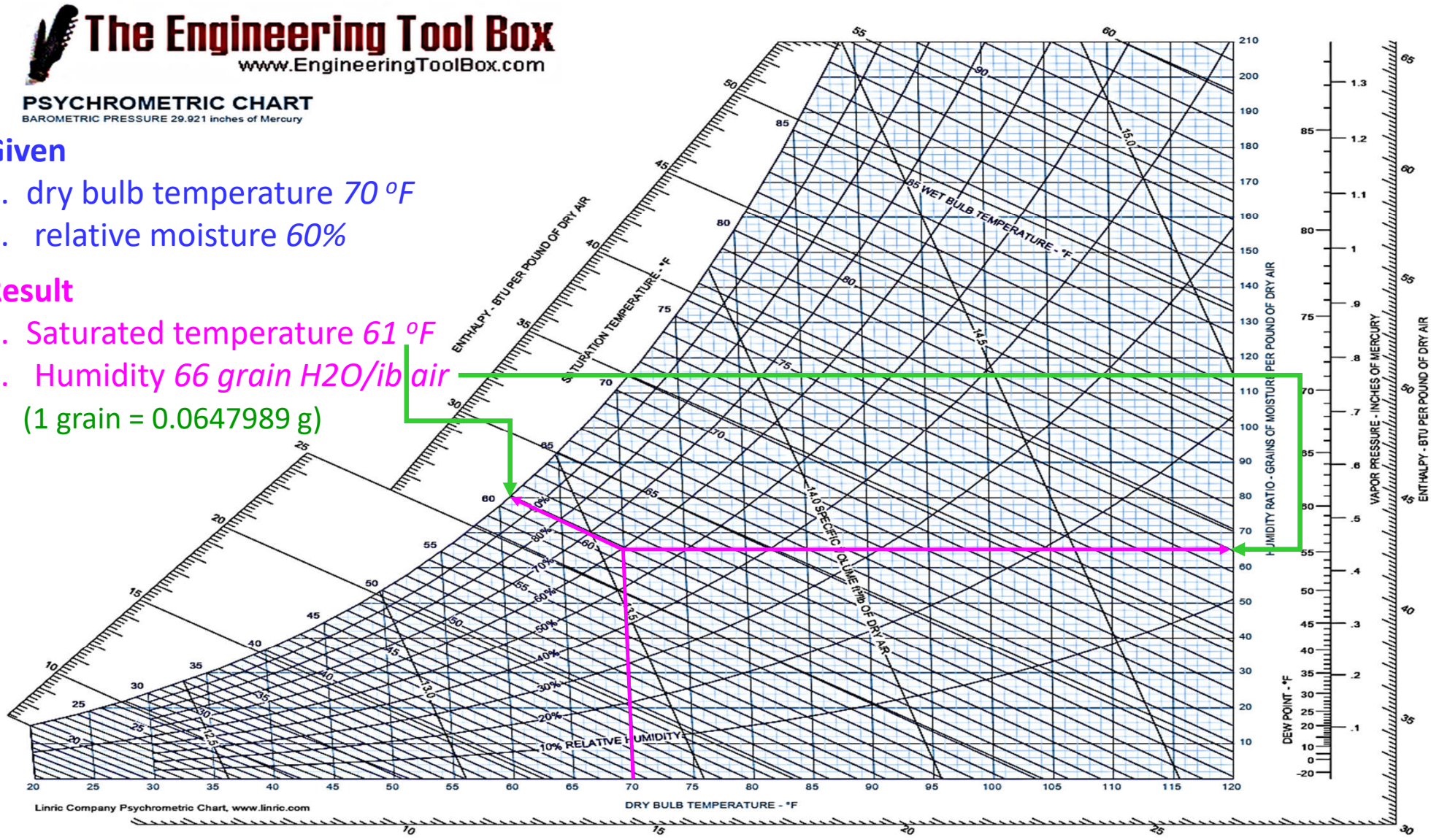
PSYCHROMETRIC CHART
BAROMETRIC PRESSURE 29.921 inches of Mercury
Given
1. dry bulb temperature 70 °F
2. relative moisture 60%
Result
1. Saturated temperature 61 °F
2. Humidity 66 grain H2O/ib air
(1 grain = 0.0647989 g)
ENTHALPY - BTU PER POUND OF DRY AIR
SATURATION TEMPERATURE - °F
85 WET BULB TEMPERATURE - °F
14.0 SPECIFIC VOLUME ft³/lb OF DRY AIR
10% RELATIVE HUMIDITY
HUMIDITY RATIO - GRAINS OF MOISTURE PER POUND OF DRY AIR
VAPOR PRESSURE - INCHES OF MERCURY
DEW POINT - °F
ENTHALPY - BTU PER POUND OF DRY AIR
DRY BULB TEMPERATURE - °F
Linric Company Psychrometric Chart, www.linric.com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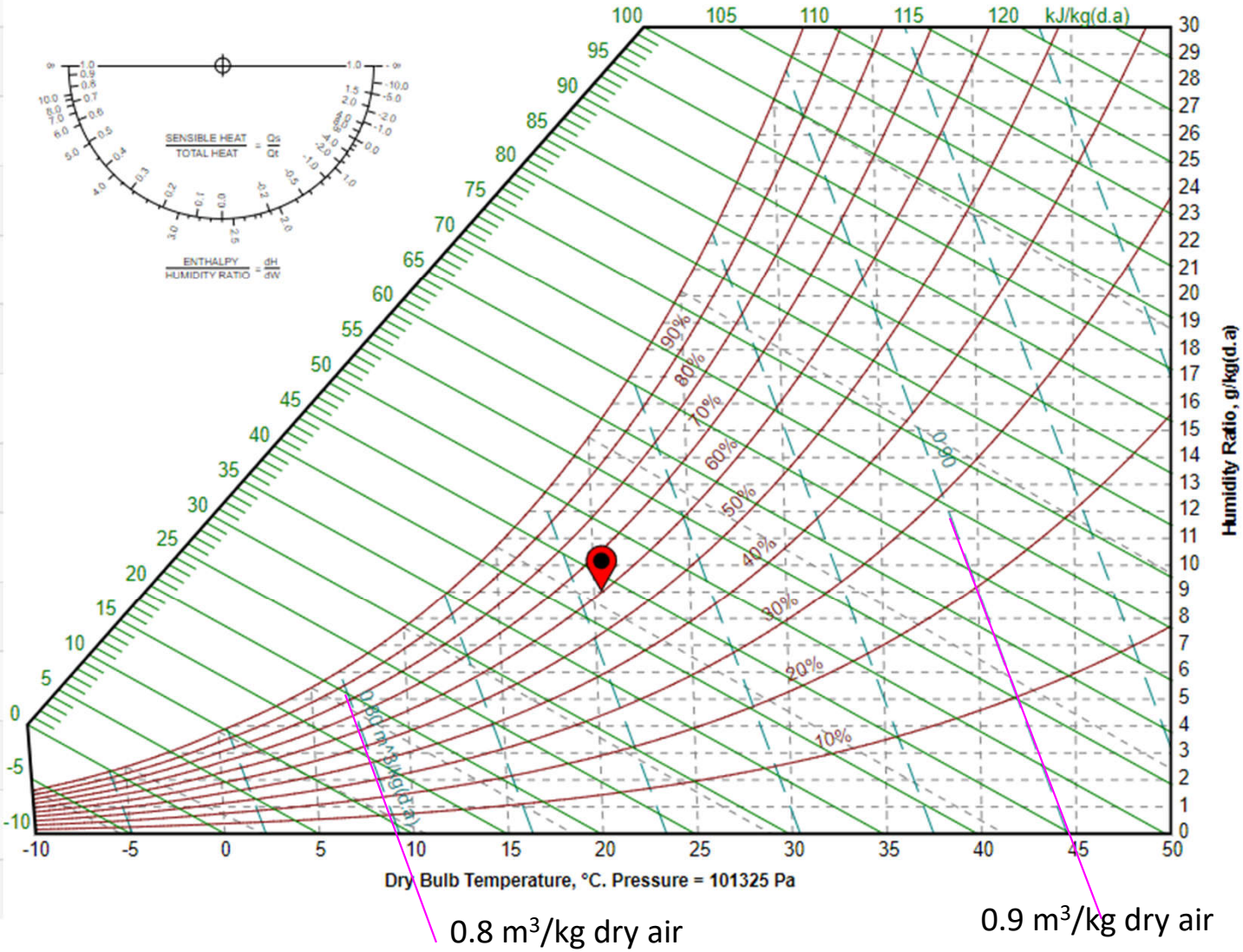
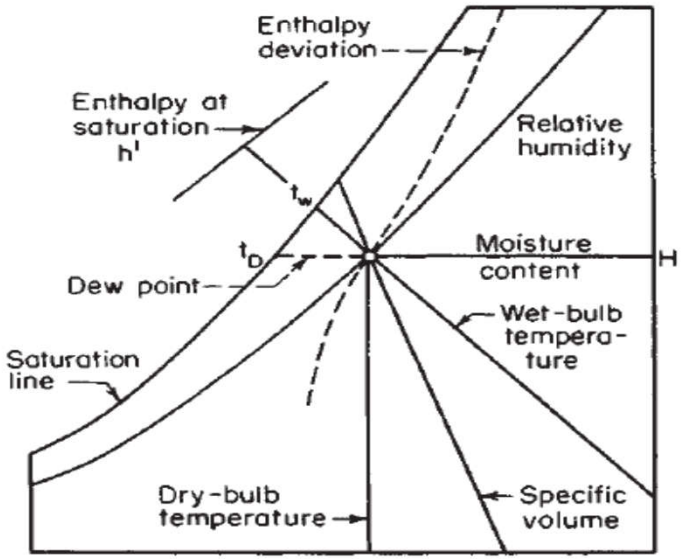
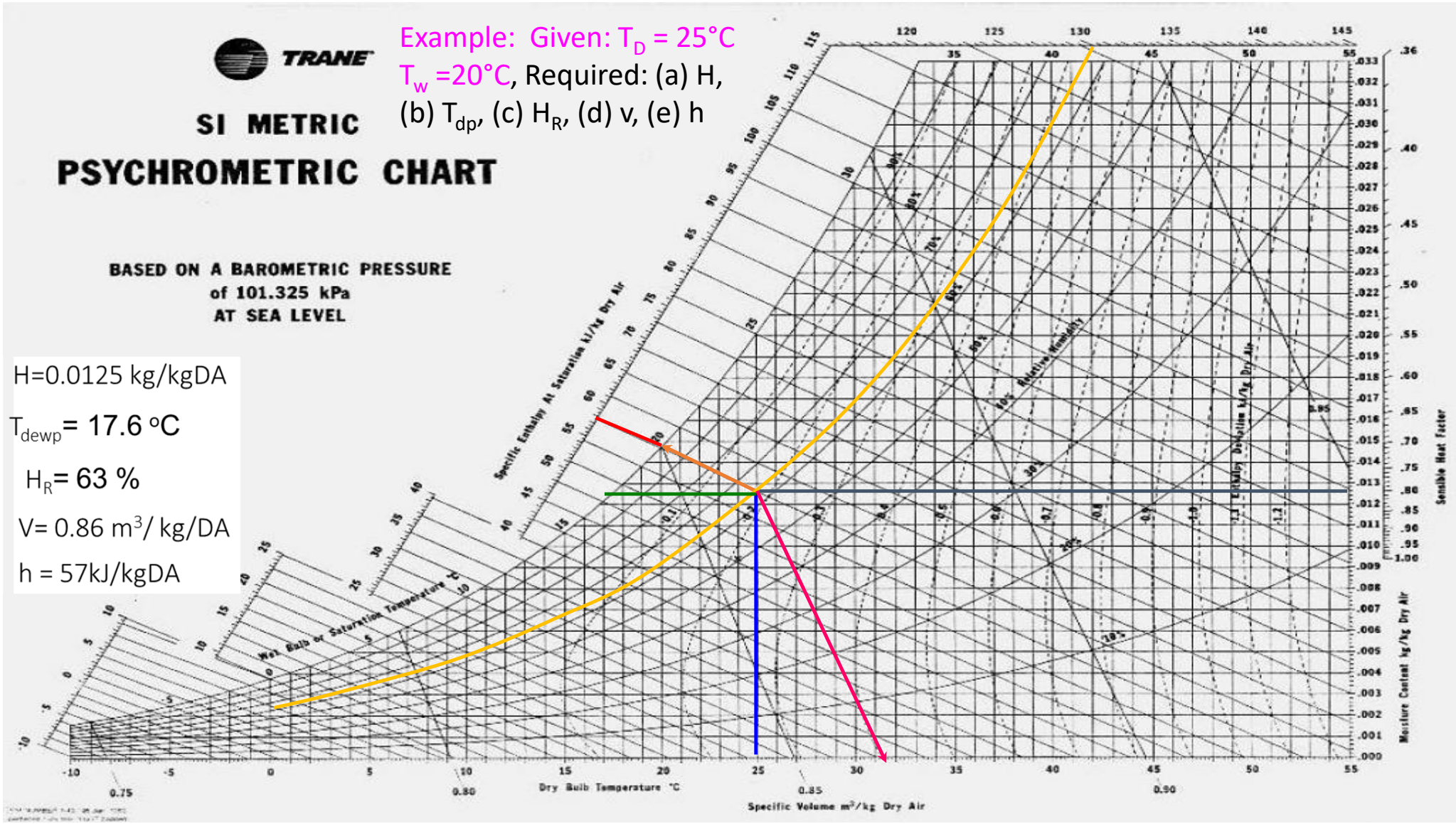
Quantity	Value	Units
P.Ambient	101325	Pa
T.Dry.Bulb	20.378	°C
Humid.Ratio	9.055	g/kg(d.a)
Rel.Humid	60.489	%
T.Wet.Bulb	15.528	°C
T.Dew	12.488	°C
T.Saturation	15.483	°C
Enthalpy	43.477	kJ/kg(d.a)
P.Vapour	1453.921	Pa
P.Sat.Vapour	2394.179	Pa
Spec.Heat	1.019	kJ/(kg.K)
Spec.Volume	0.844	m^3/kg(d.a)
Density	1.196	kg/m^3




Enthalpy deviation
Enthalpy at saturation h'
Relative humidity
t_w
t_D
Moisture content
H
Dew point
Wet-bulb temperature
Saturation line
Dry-bulb temperature
Specific volume

Specific Enthalpy At Saturation kJ/kg Dry Air
Wet Bulb or Saturation Temperature °C
Relative Humidity
Enthalpy Deviation kJ/kg Dry Air
Sensible Heat Factor
Moisture Content kg/kg Dry Air
Dry Bulb Temperature °C
Specific Volume m³/kg Dry Air
0.75
0.80
0.85
0.90


TRANE
SI METRIC
PSYCHROMETRIC CHART
BASED ON A BAROMETRIC PRESSURE
of 101.325 kPa
AT SEA LEVEL
Example: Given: T_D = 25°C
T_w =20°C, Required: (a) H,
(b) T_{dp}, (c) H_R, (d) v, (e) h
H=0.0125 kg/kgDA
T_{dewp}= 17.6 °C
H_R= 63 %
V= 0.86 m³/ kg/DA
h = 57kJ/kgDA
Dry Bulb Temperature °C
Specific Volume m³/kg Dry Air
Wet Bulb or Saturation Temperature °C
Specific Enthalpy At Saturation kJ/kg Dry Air
Moisture Content kg/kg Dry Air
Sensible Heat Factor

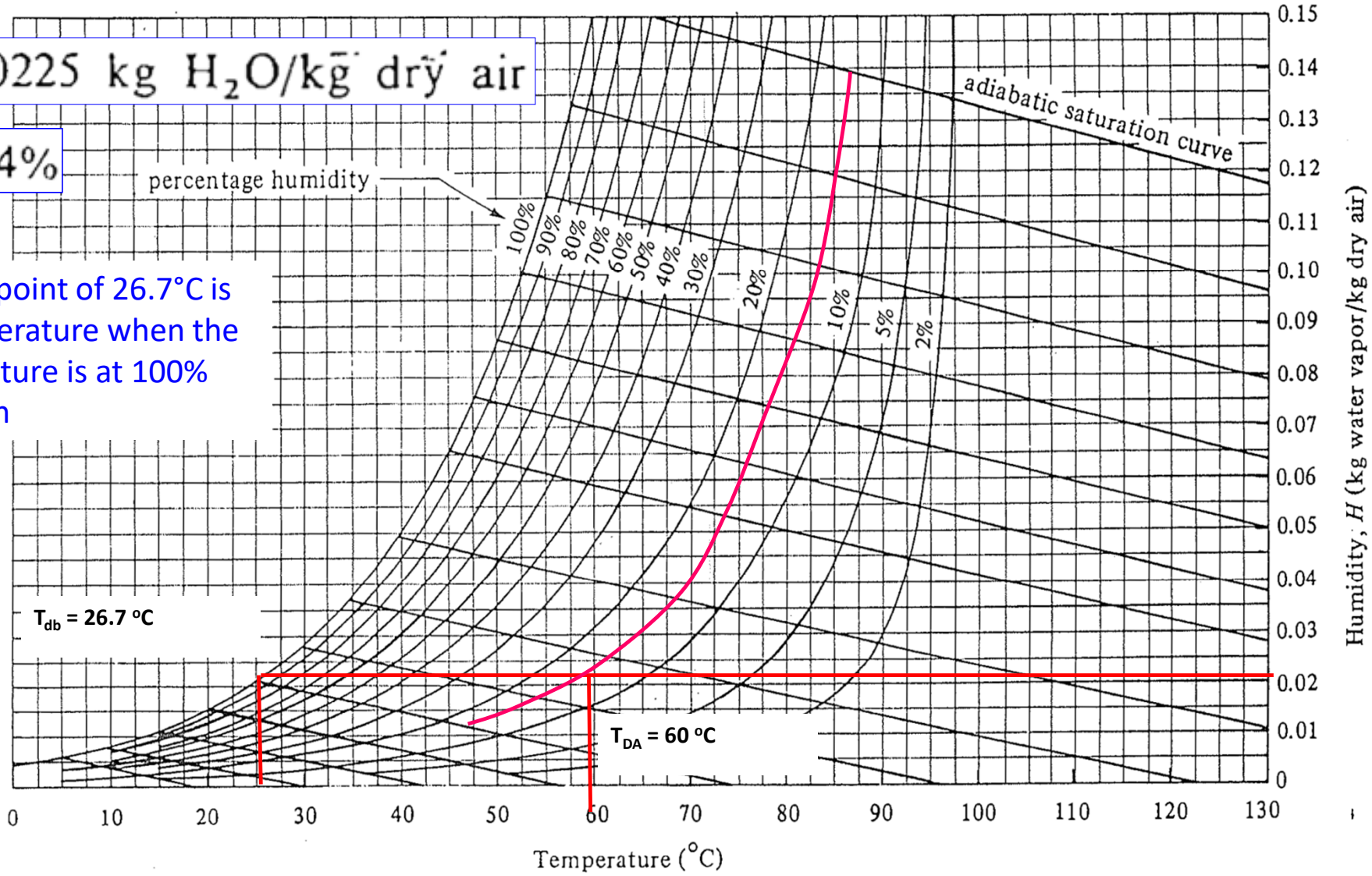
EXAMPLE 9.3-2. Use of Humidity Chart

Air entering a dryer has a temperature (dry bulb temperature) of 60°C (140°F) and a dew point of 26.7°C (80°F). Using the humidity chart, determine the actual humidity H, percentage humidity H_P, humid heat c_S, and the humid volume v_H in SI and English units.

$H = 0.0225$ kg H_2O/kg dry air

$H_P = 14\%$

- The dew point of 26.7°C is the temperature when the given mixture is at 100% saturation



$$c_S \text{ kJ/kg dry air} \cdot \text{K} = 1.005 + 1.88H$$

$$c_s = 1.005 + 1.88(0.0225)$$

$$= 1.047 \text{ kJ/kg dry air} \cdot \text{K} \quad \text{or} \quad 1.047 \times 10^3 \text{ J/kg} \cdot \text{K}$$

$$c_s = 0.24 + 0.45(0.0225)$$

$$= 0.250 \text{ btu/lb}_\text{m} \text{ dry air} \cdot {}^\circ\text{F} \qquad \text{(English)}$$

$$v_H = (2.83 \times 10^{-3} + 4.56 \times 10^{-3} \times 0.0225)(60 + 273)$$

$$= 0.977 \text{ m}^3\text{/kg dry air}$$

In English units,

$$v_H = (0.0252 + 0.0405 \times 0.0225)(460 + 140) = 15.67 \text{ ft}^3\text{/lb}_\text{m} \text{ dry air}$$

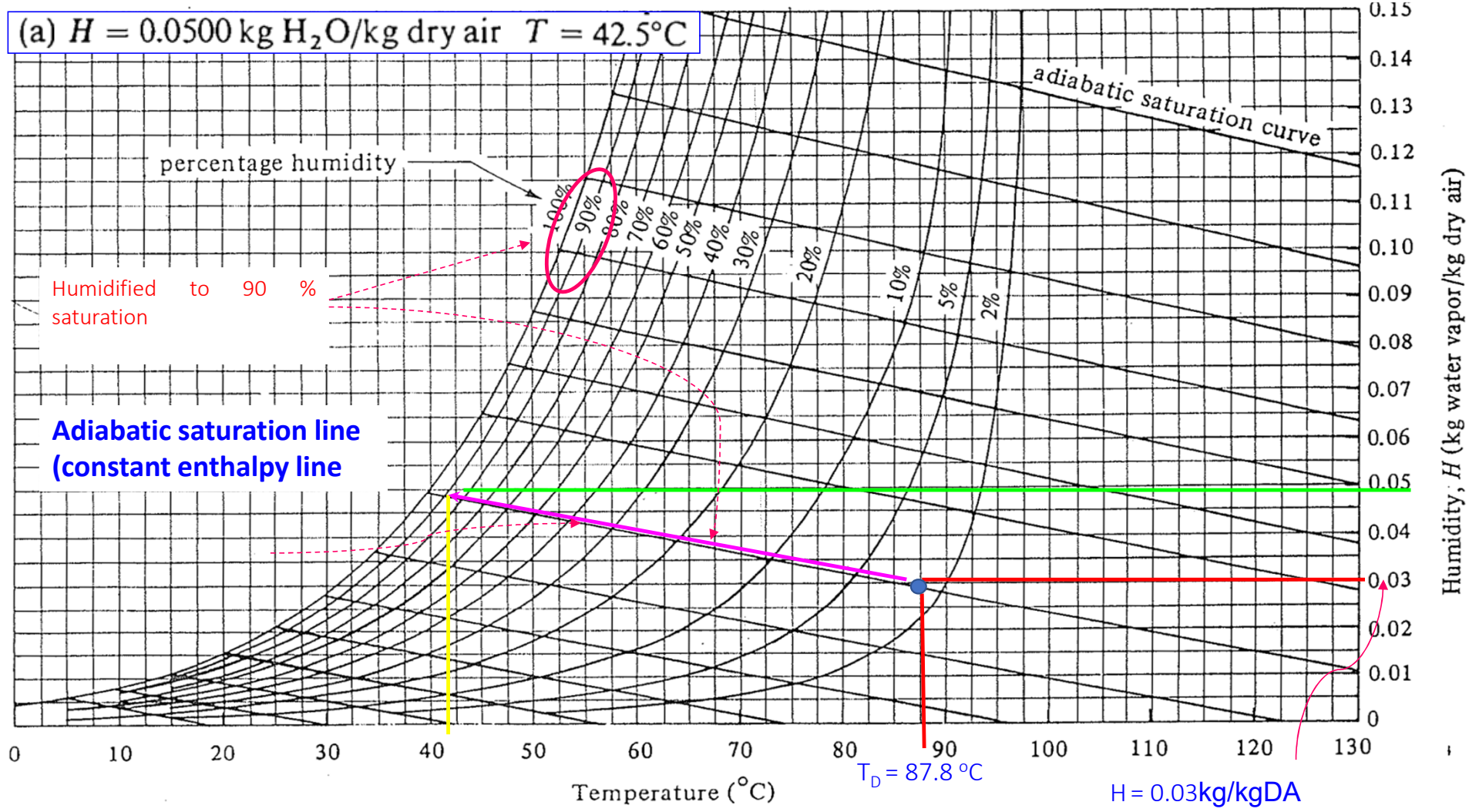
EXAMPLE 9.3-3. Adiabatic Saturation of Air

An air stream at 87.8°C having a humidity $H = 0.030$ kg H_2O/kg dry air is contacted in an adiabatic saturator with water. It is cooled and humidified to 90% saturation.

(a) What are the final values of H and T?

(b) For 100% saturation, what would be the values of H and T?

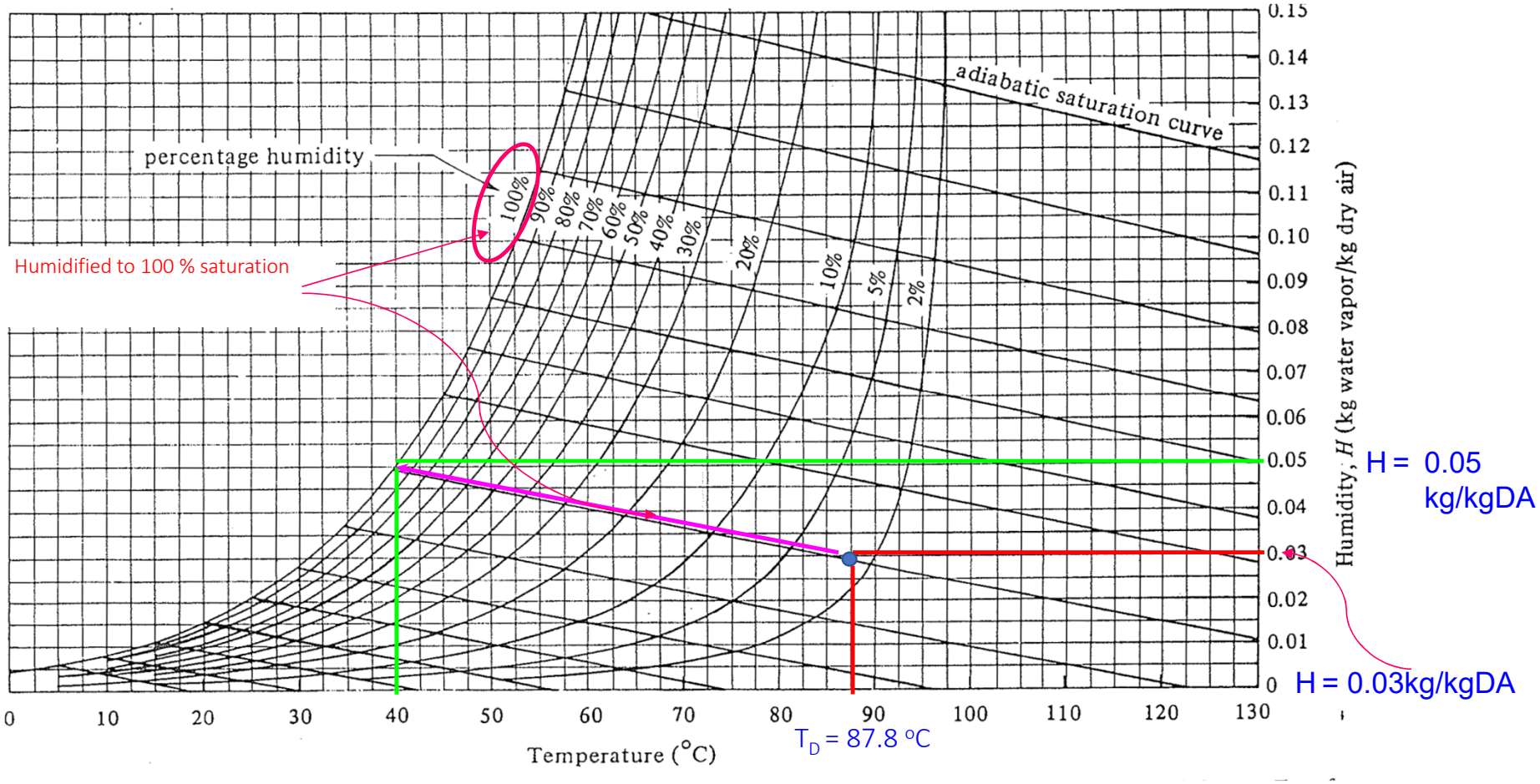
87.8°C having a humidity $H = 0.030$ kg H_2O/kg dry air



For 100% saturation, what would be the values of H and T?

Solution:

(b) $T = 40.5°C$, $H = 0.0505$ kg H_2O/kg dry air



EXAMPLE 9.3-4. Wet Bulb Temperature and Humidity

A water vapor–air mixture having a dry bulb temperature of $T = 60°C$ is passed over a wet bulb as shown in Fig. 9.3-4, and the wet bulb temperature obtained is $T_W = 29.5°C$. What is the humidity of the mixture?

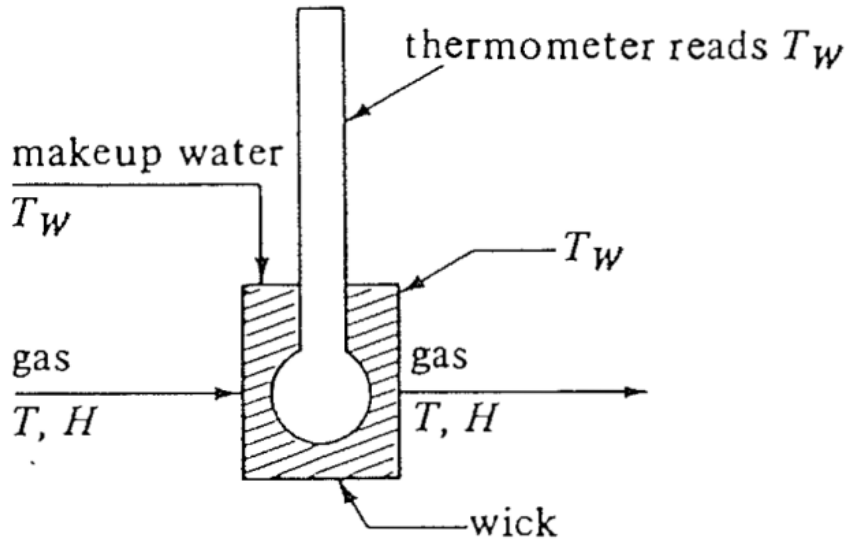


FIGURE 9.3-4. *Measurement of wet bulb temperature.*

Solution

$T = 60°C$, $H = 0.0135\ \text{kg}\,H_2O/\text{kg dry air.}$