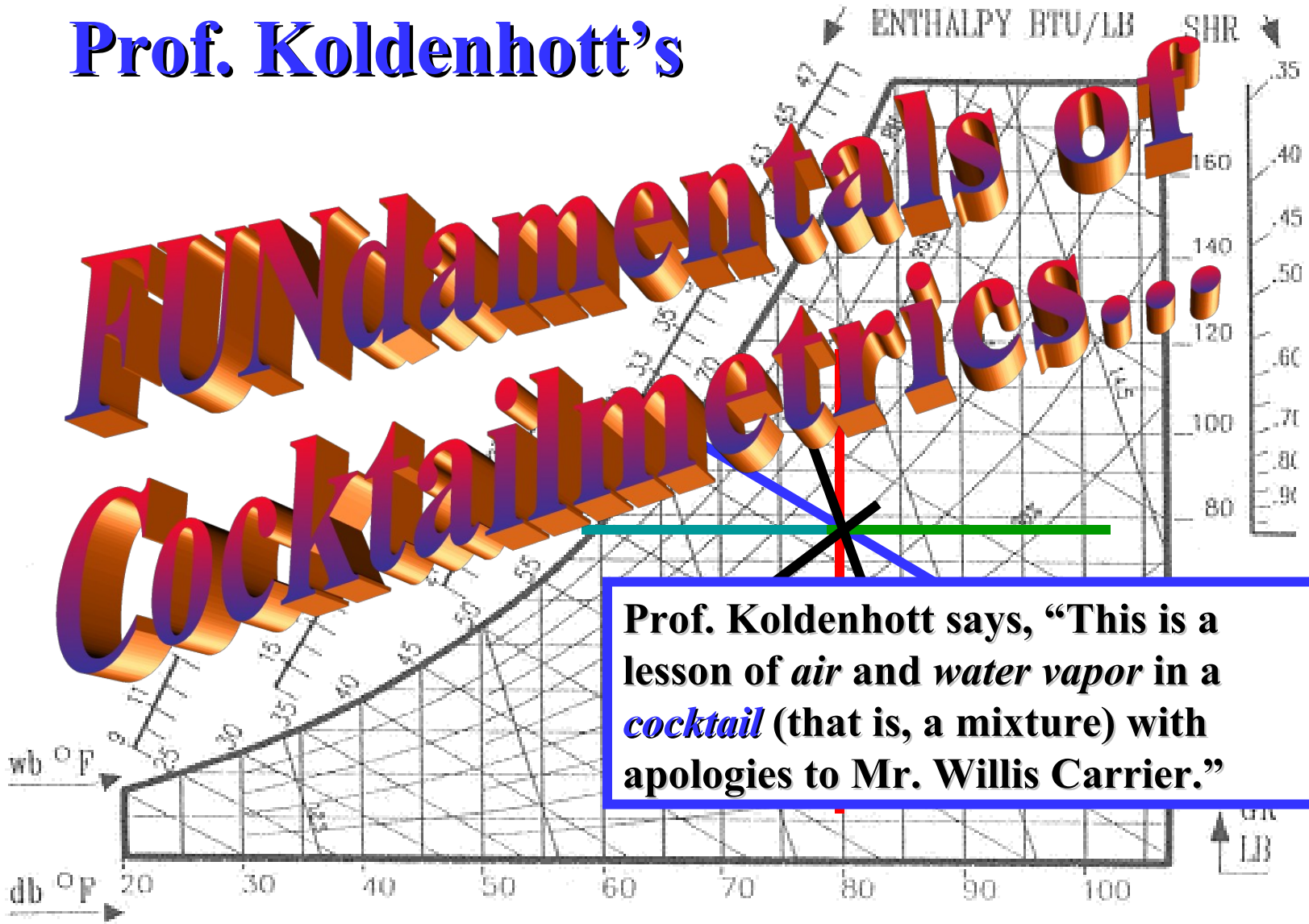


Prof. Koldenhott's

FUNdamentals of Cocktailmetrics



Your instructor...

Mr. Terry L. Robinson
aka



N.A.T.E. certified

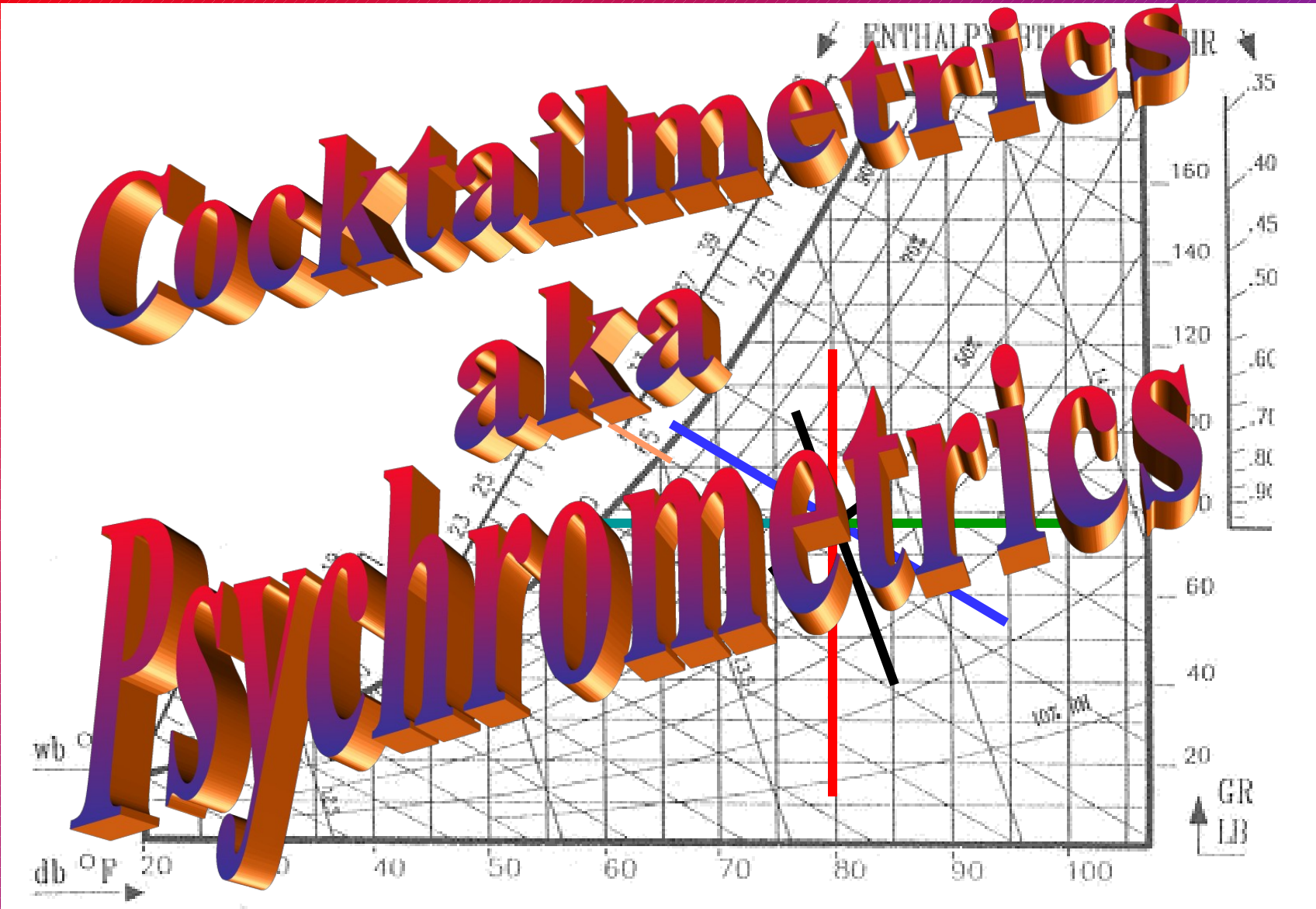


Active Member



***Member of Council of Refrigeration and
Air Conditioning Educators***





**In the early 1900's, there was a young engineer
Working For Buffalo Forge Company that received
a '*flash of genius*' while waiting for a train.**

**It was a foggy night and he was going over in his
mind the problem of *temperature and humidity*
control. By the time the train arrived, Carrier had
an understanding of the relationship between
temperature, humidity and dew point.**

That young engineer was...

...*Willis H. Carrier*

*from The Father of Cool Willis Haviland Carrier: The History of Air Conditioning by Mary
Bellis on www.about.com*



What Mr. Carrier's 'flash of genius' that day came to be known as Psychrometry...

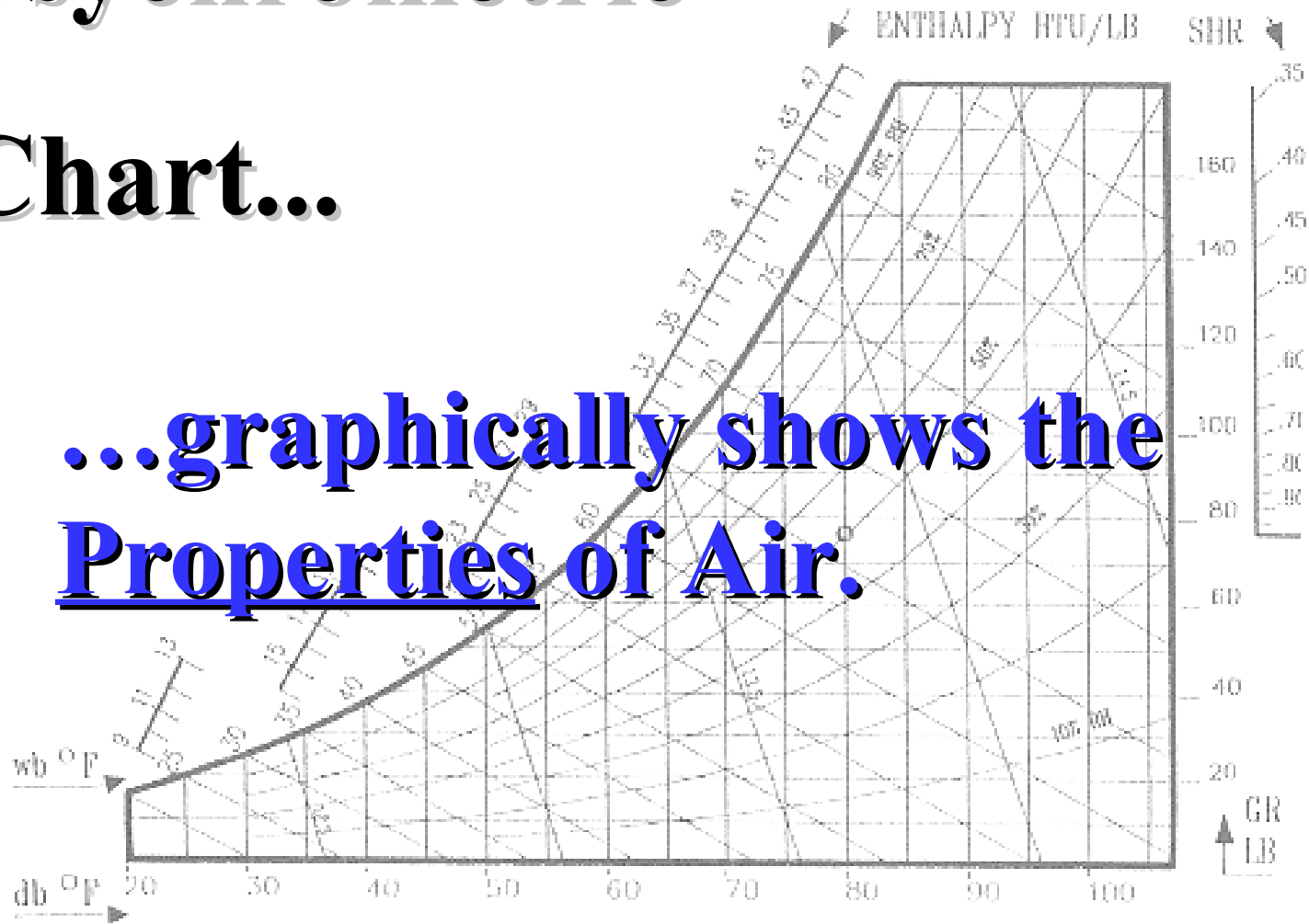
*...the study of air and
water vapor in mixture.*

**"It's this 'mixture' idea that leads me to nickname Psychrometrics, *Cocktailmetrics*."
says Prof. Koldenhott**

Psychrometric

Chart...

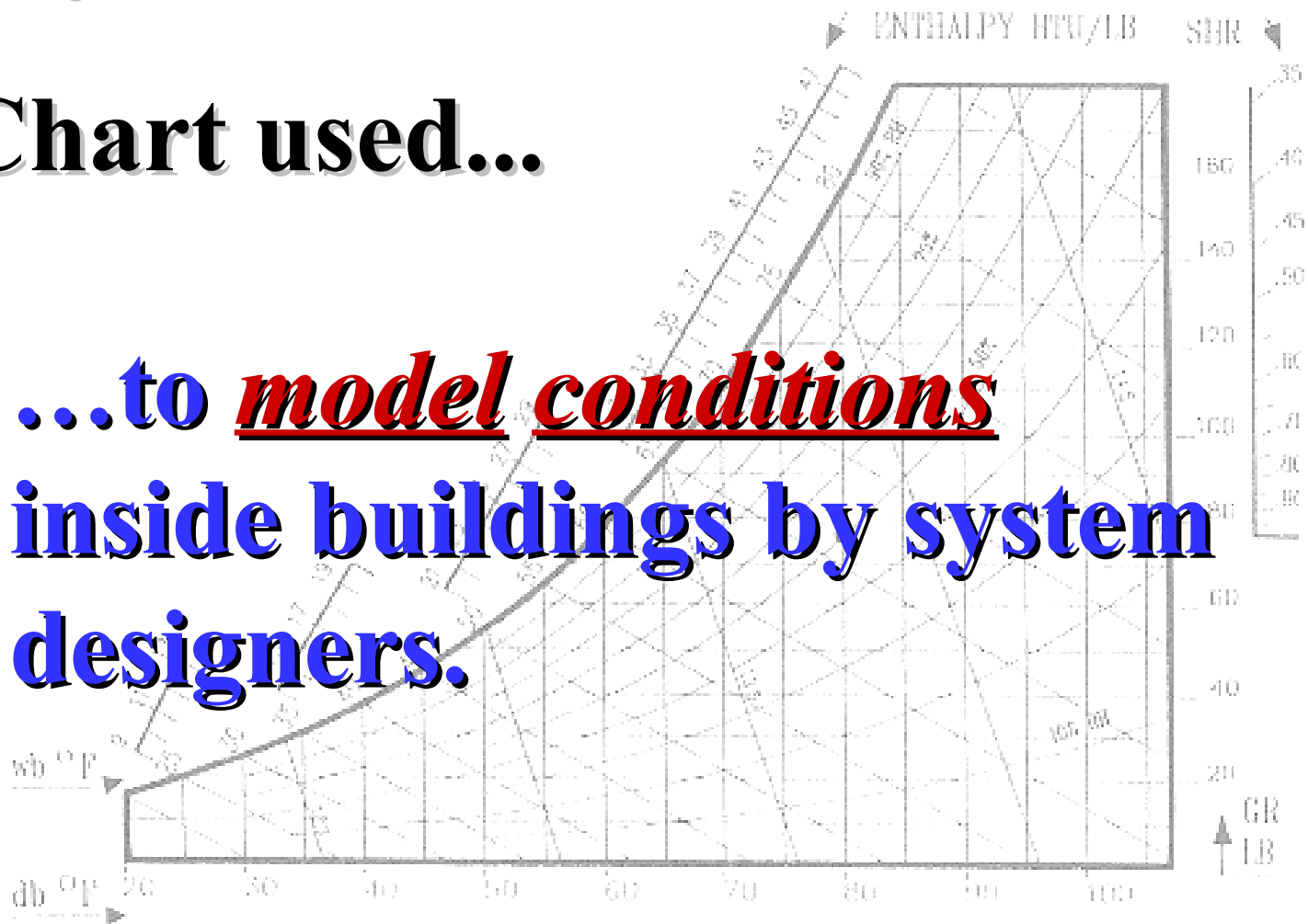
**...graphically shows the
Properties of Air.**



Psychrometric

Chart used...

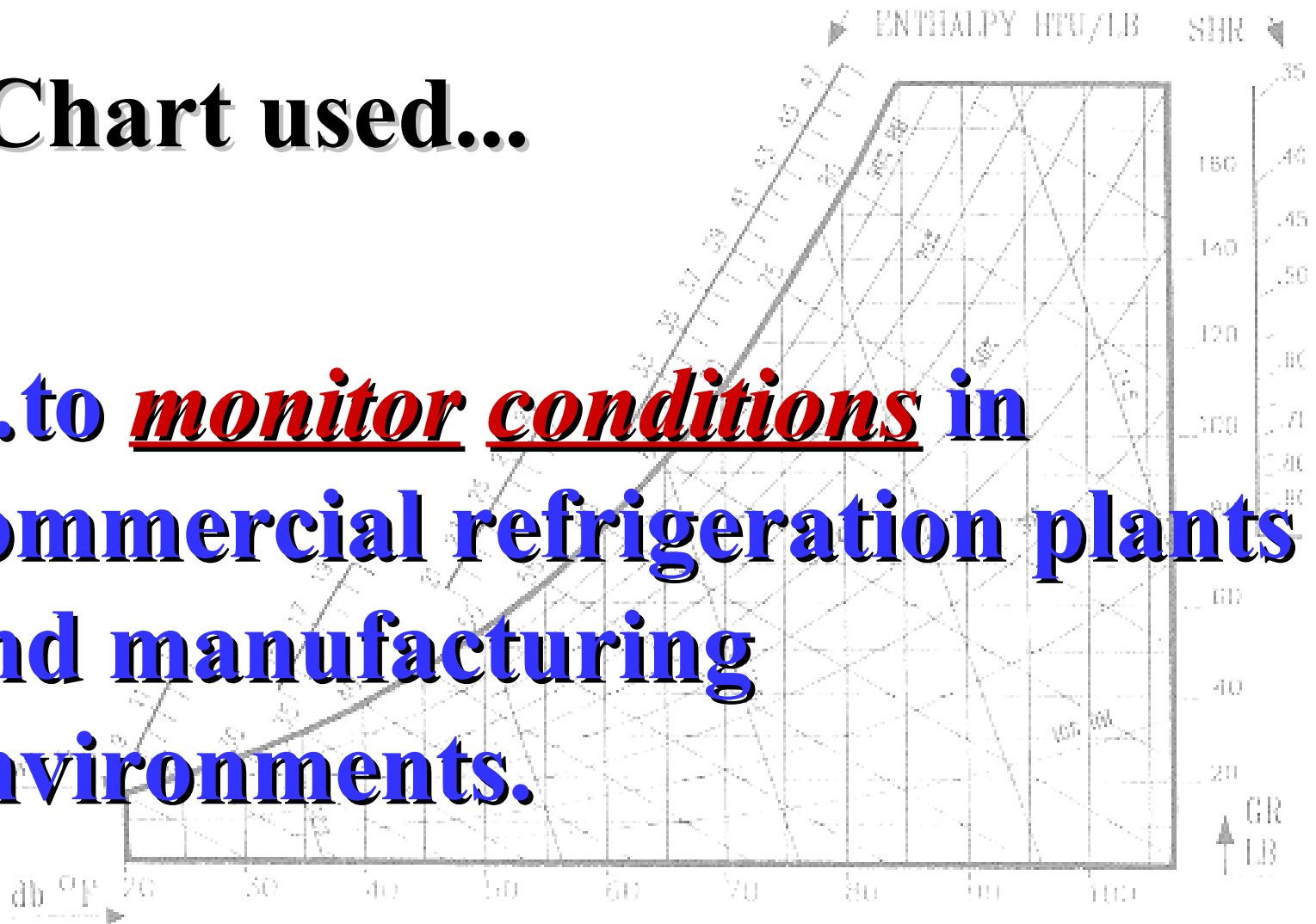
...to model conditions
inside buildings by system
designers.



Psychrometric

Chart used...

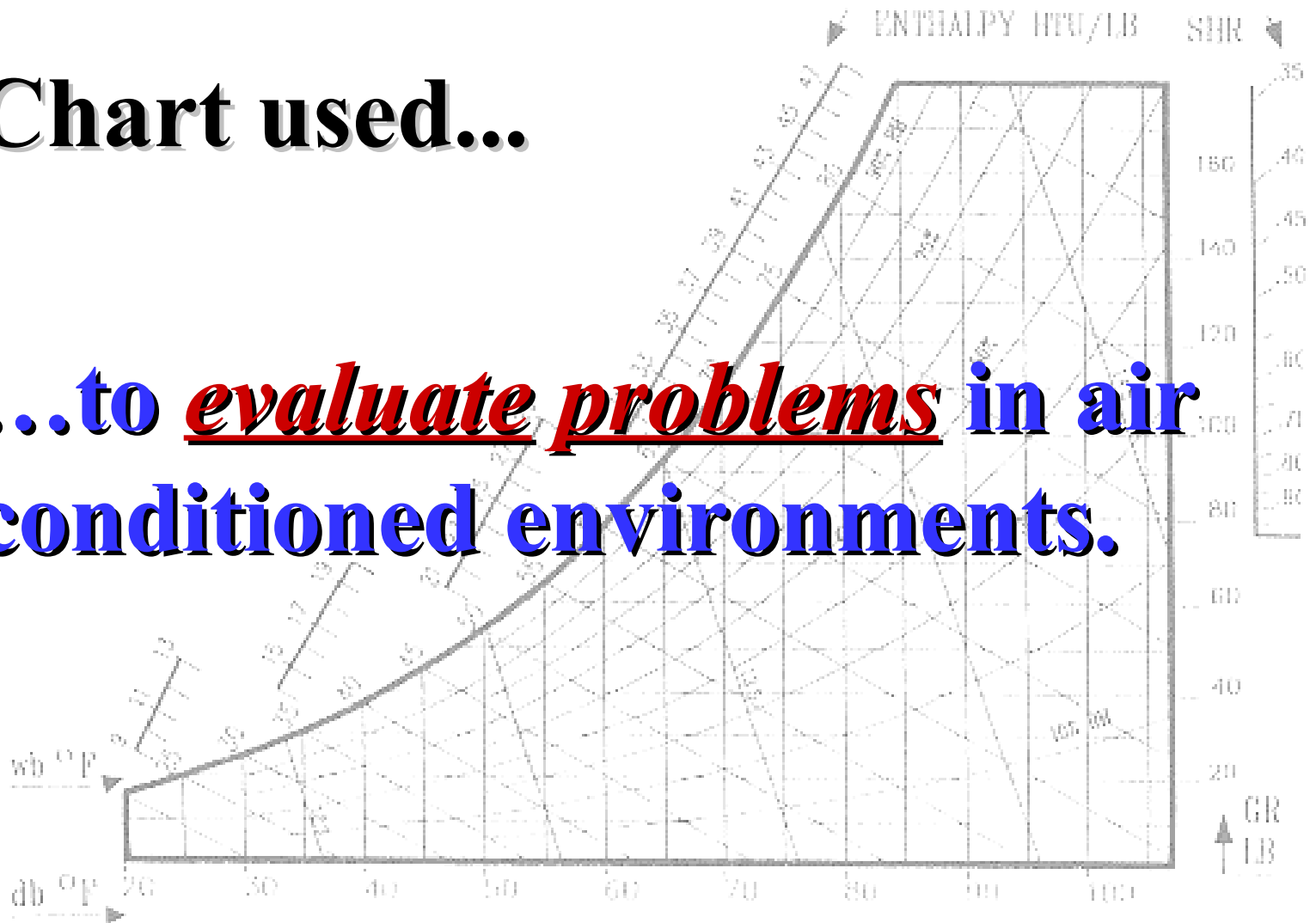
...to **monitor conditions** in commercial refrigeration plants and manufacturing environments.



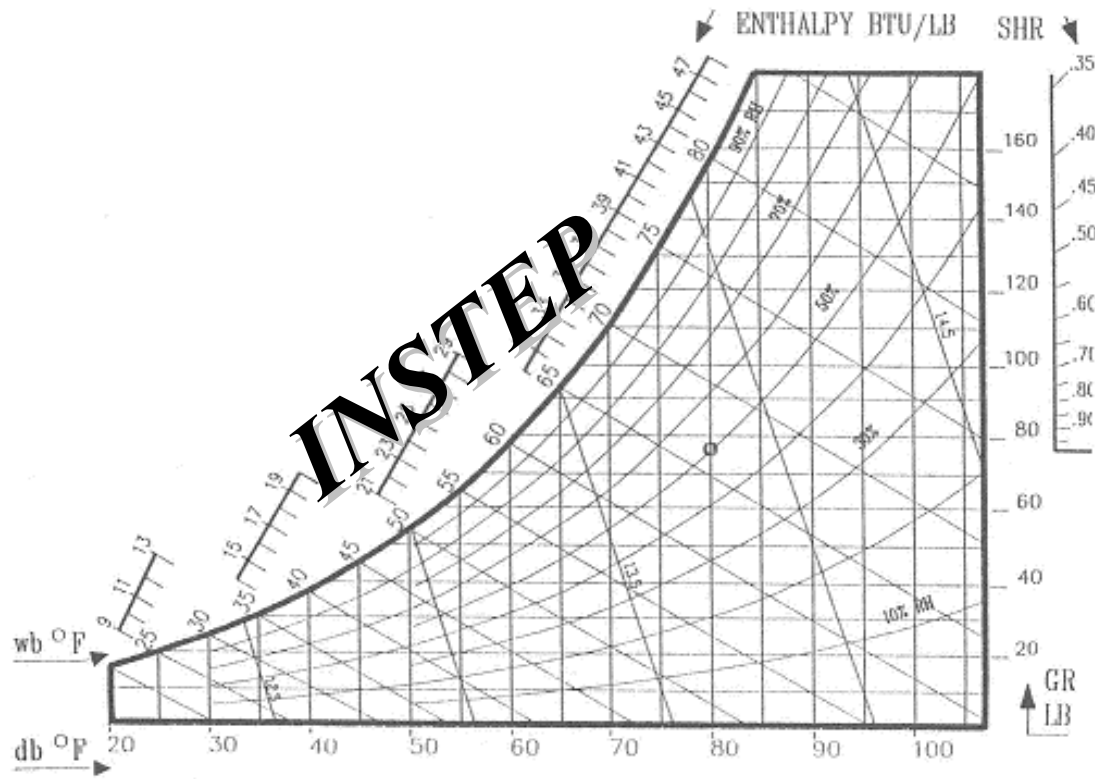
Psychrometric

Chart used...

...to evaluate problems in air conditioned environments.



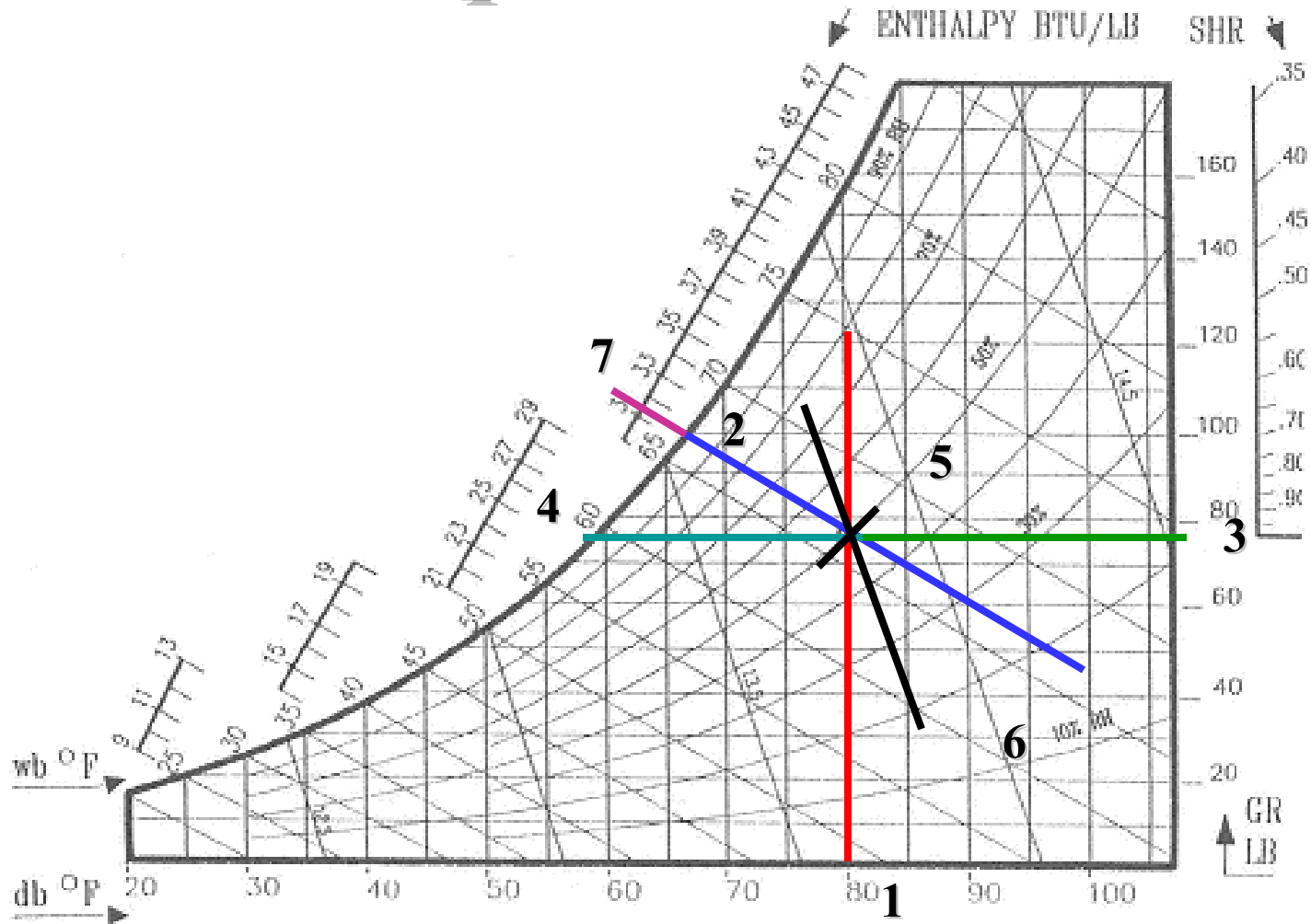
Structure...



H
E
E
L

SOLE

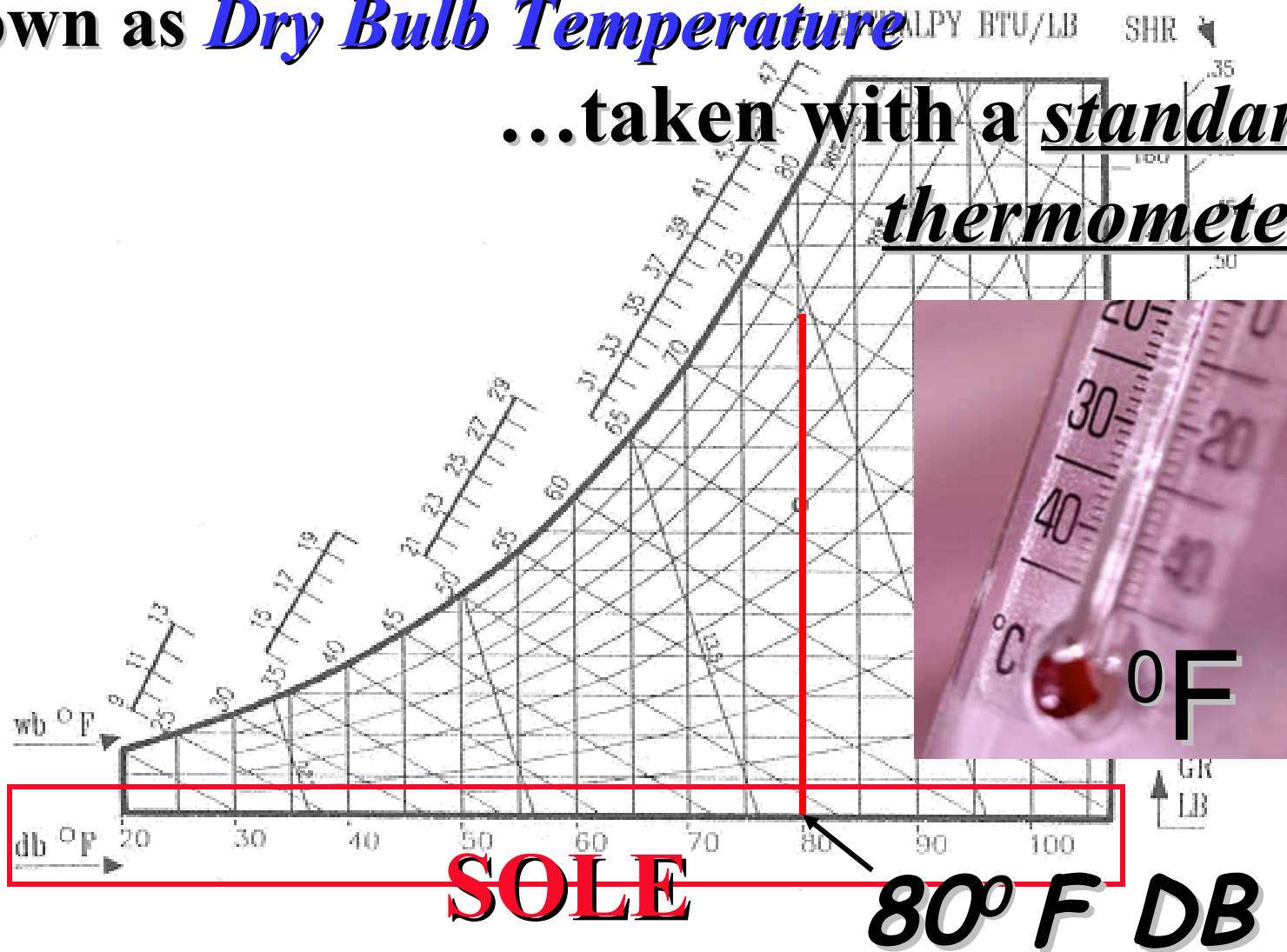
Seven Properties of Air



Seven Properties of Air...

1. Prof. Koldenhott's *Dry Noodle Temp* better known as *Dry Bulb Temperature*

...taken with a standard thermometer.



SOLE

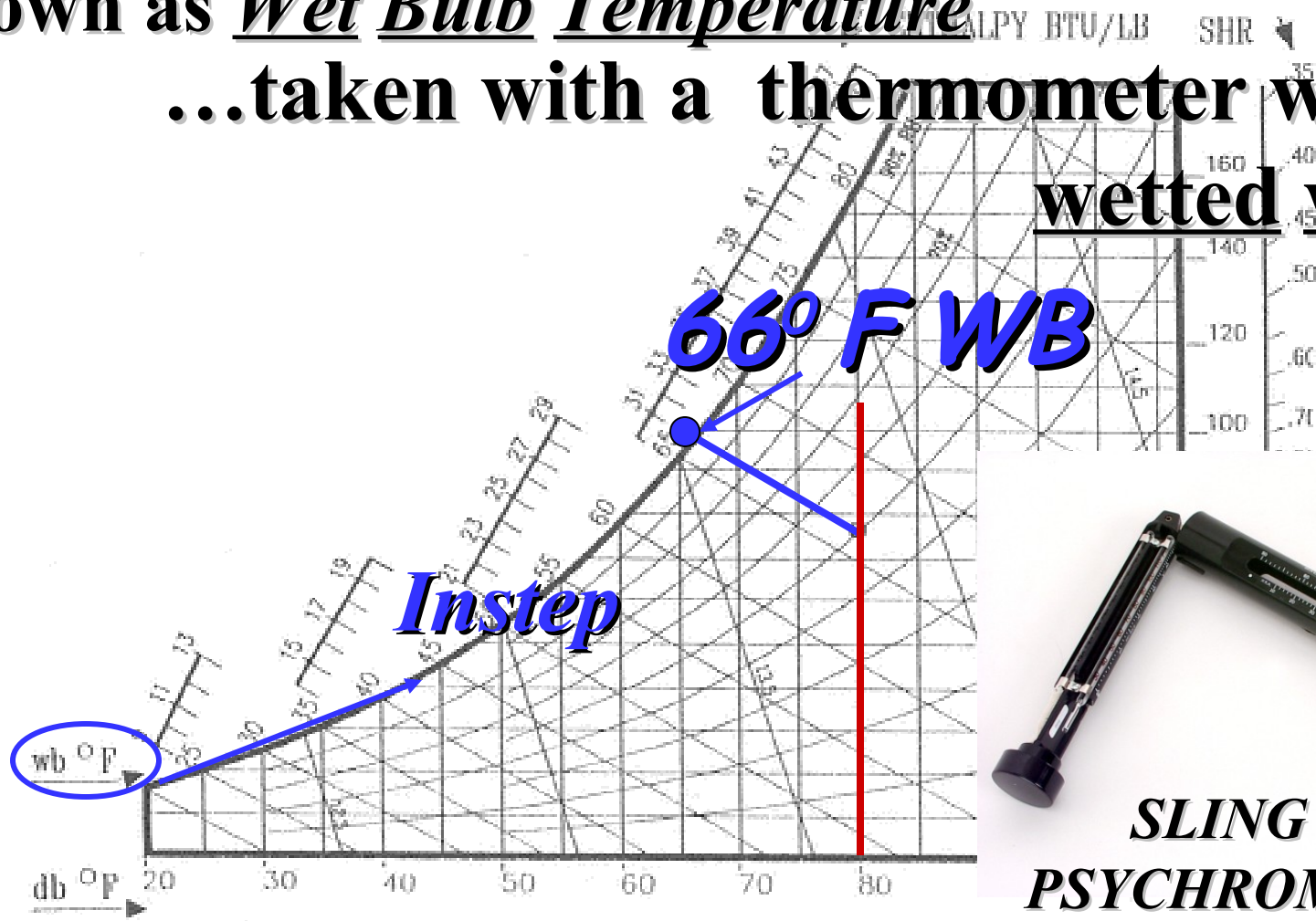
80° F DB

| PROPERTY OF AIR | SYMBOL | EXPRESSED BY | SCALE LOCATION | LINE DRAWN |
|-----------------|--------|--------------|----------------|-------------|
| DRY BULB TEMP | DB | °F | SOLE BOTTOM | STRAIGHT UP |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Seven Properties of Air...

2. Prof. Koldenhott's *Wet Noodle Temp* better known as *Wet Bulb Temperature*

...taken with a thermometer with a wetted wick.

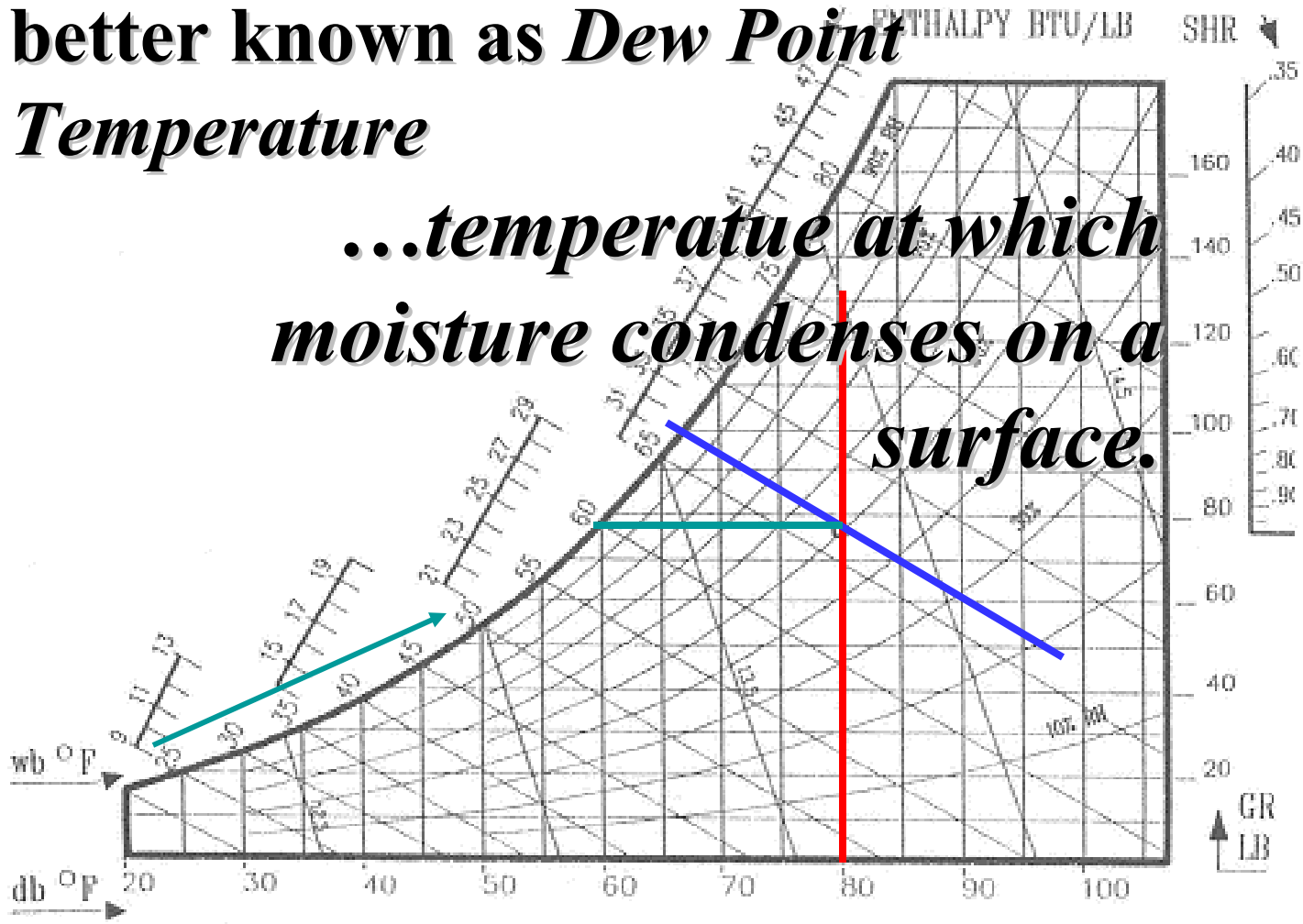


***SLING
PSYCHROMETER***

| PROPERTY OF AIR | SYMBOL | EXPRESSED BY | SCALE LOCATION | LINE DRAWN |
|-----------------|--------|--------------|----------------|-------------|
| DRY BULB TEMP | DB | °F | SOLE BOTTOM | STRAIGHT UP |
| WET BULB TEMP | WB | °F | INSTEP | SLANTED |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Seven Properties of Air...
3. Prof. Koldenhott's *Wet Spot Temp*
 better known as *Dew Point*
Temperature

*...temperature at which
 moisture condenses on a
 surface.*



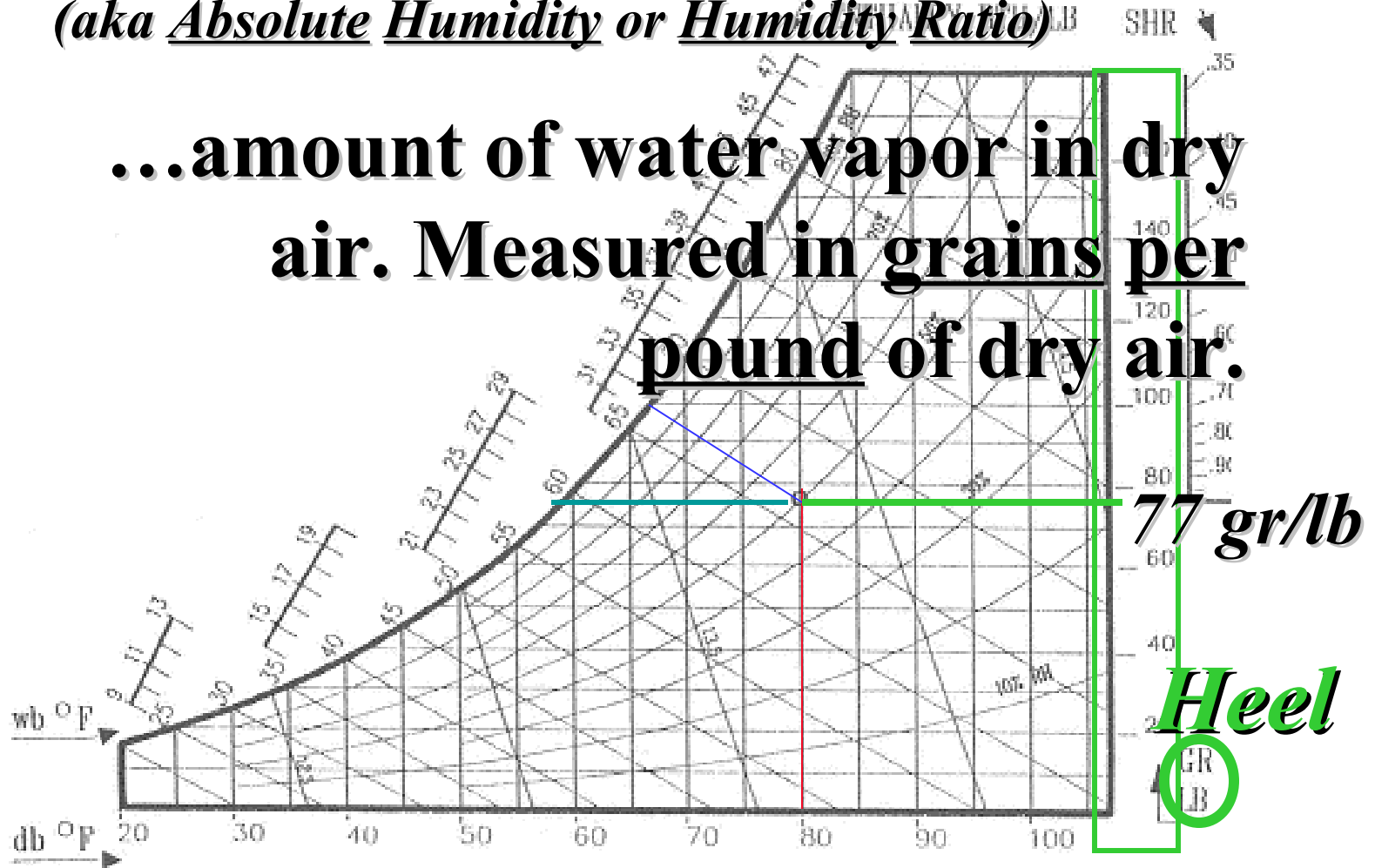
| PROPERTY OF AIR | SYMBOL | EXPRESSED BY | SCALE LOCATION | LINE DRAWN |
|-----------------|--------|--------------|----------------|--------------------|
| DRY BULB TEMP | DB | °F | SOLE BOTTOM | STRAIGHT UP |
| WET BULB TEMP | WB | °F | INSTEP | SLANTED |
| DEW POINT TEMP | DP | °F | INSTEP | HORIZONTAL TO LEFT |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Seven Properties of Air...

4. Specific Humidity

(aka Absolute Humidity or Humidity Ratio)

...amount of water vapor in dry air. Measured in grains per pound of dry air.



| PROPERTY OF AIR | SYMBOL | EXPRESSED BY | SCALE LOCATION | LINE DRAWN |
|--------------------------|---------------|---------------------|------------------------|----------------------------|
| DRY BULB TEMP | DB | °F | SOLE BOTTOM | STRAIGHT UP |
| WET BULB TEMP | WB | °F | INSTEP | SLANTED |
| DEW POINT TEMP | DP | °F | INSTEP | HORIZONTAL TO LEFT |
| SPECIFIC HUMIDITY | W | GR/LB | HEEL RIGHT VERT | HORIZONTAL TO RIGHT |
| | | | | |
| | | | | |
| | | | | |

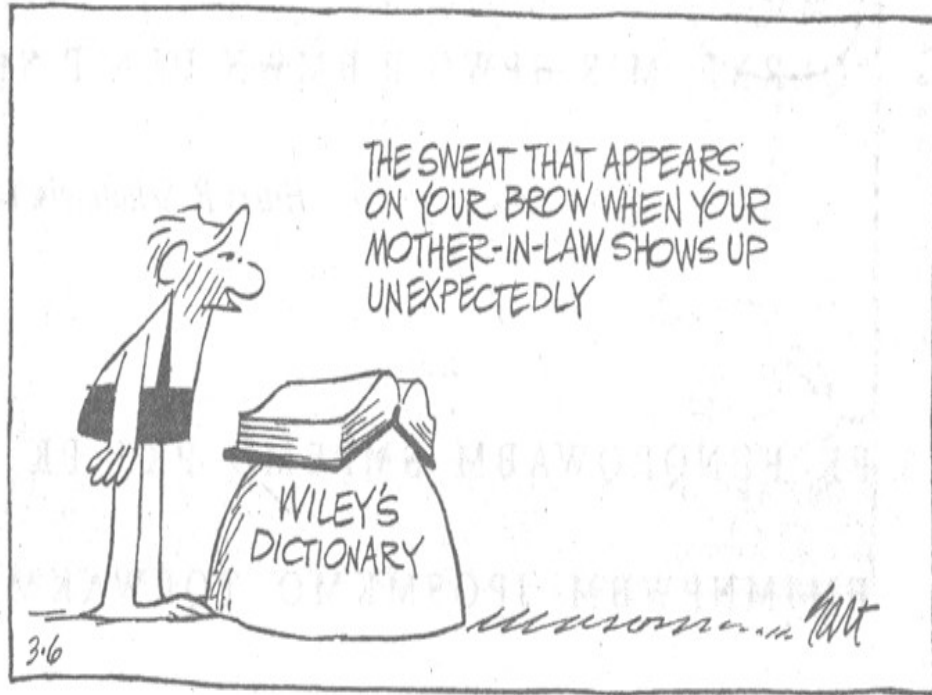
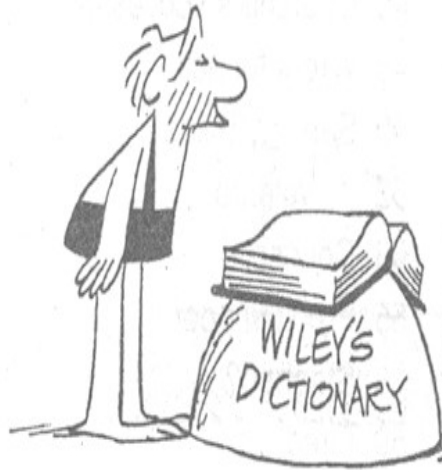
Seven Properties of Air...

5. Relative Humidity

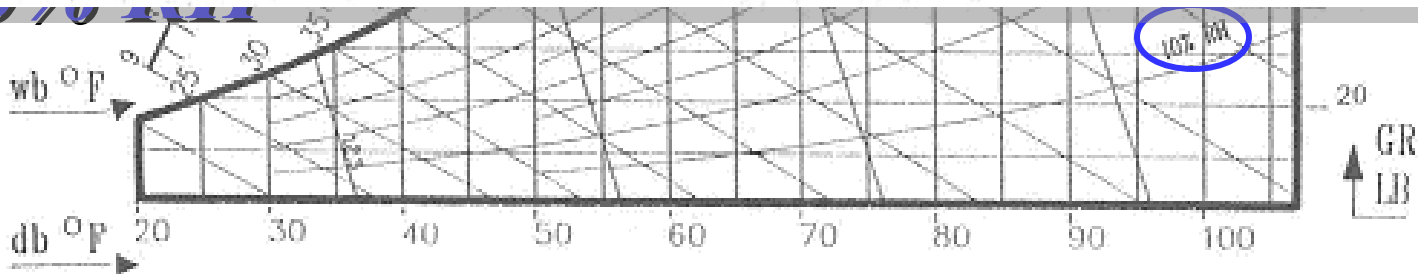
B.C.

By Johnny Hart

relative humidity



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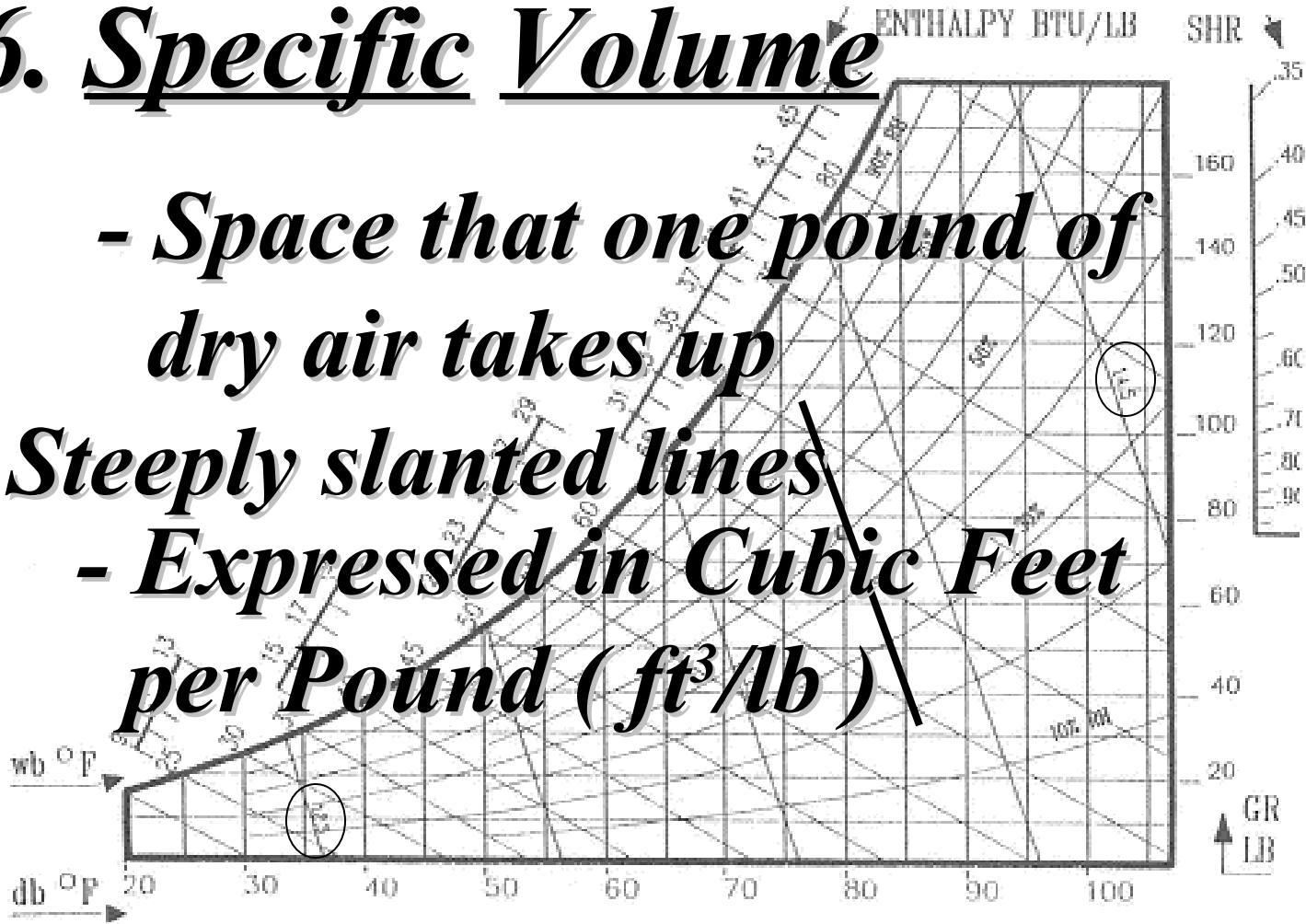


| PROPERTY OF AIR | SYMBOL | EXPRESSED BY | SCALE LOCATION | LINE DRAWN |
|--------------------------|-----------|--------------|-----------------|---------------------|
| DRY BULB TEMP | DB | °F | SOLE BOTTOM | STRAIGHT UP |
| WET BULB TEMP | WB | °F | INSTEP | SLANTED |
| SPECIFIC HUMIDITY | W | GR/LB | HEEL RIGHT VERT | HORIZONTAL TO RIGHT |
| DEW POINT TEMP | DP | °F | INSTEP | HORIZONTAL TO LEFT |
| RELATIVE HUMIDITY | RH | %RH | CURVED | CURVED |
| | | | | |
| | | | | |

Seven Properties of Air...

6. Specific Volume

- *Space that one pound of dry air takes up*
- *Steeply slanted lines*
- *Expressed in Cubic Feet per Pound (ft^3/lb)*

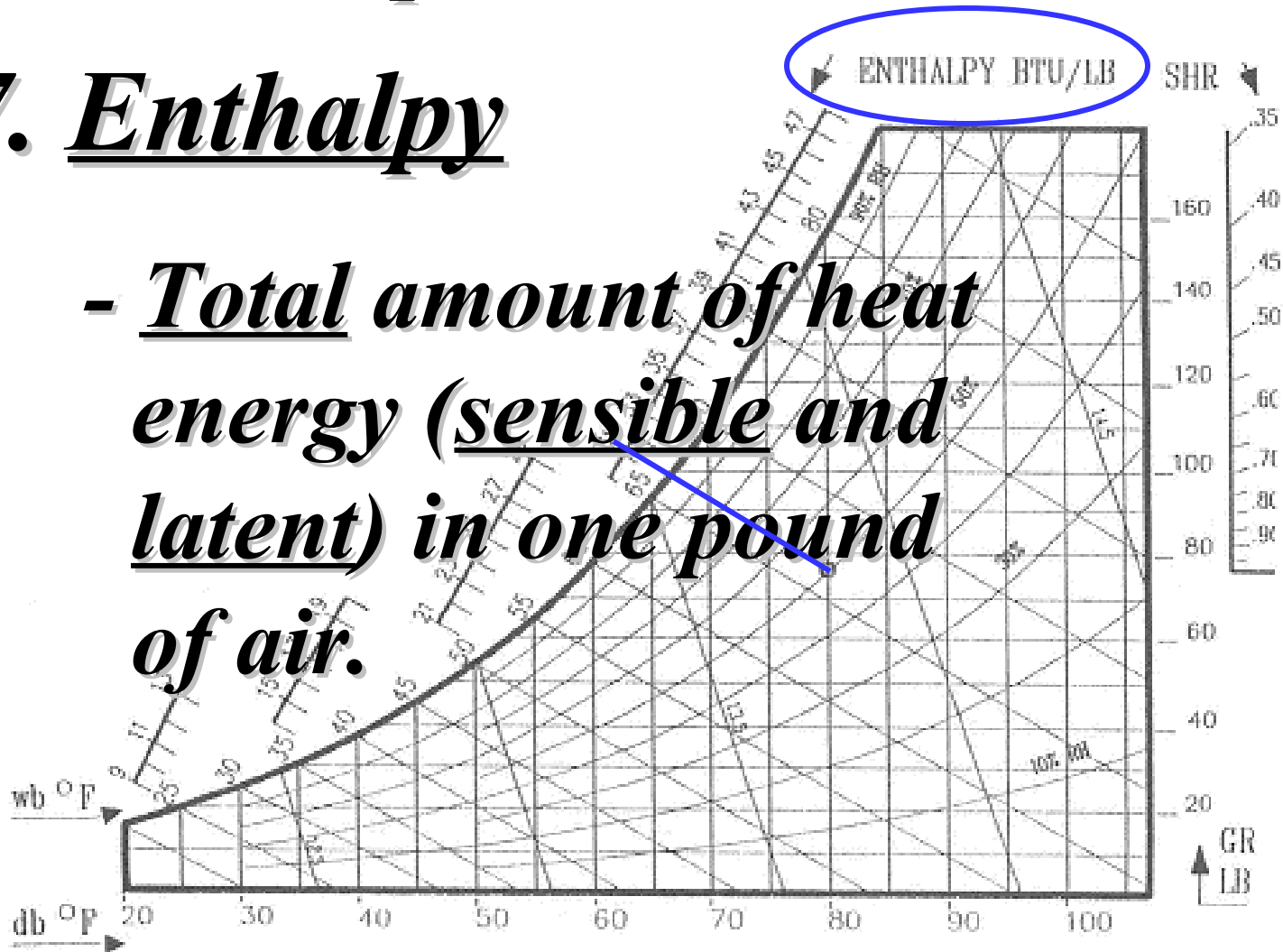


| PROPERTY OF AIR | SYMBOL | EXPRESSED BY | SCALE LOCATION | LINE DRAWN |
|------------------------|----------|--------------------------|------------------------|------------------------|
| DRY BULB TEMP | DB | °F | SOLE BOTTOM | STRAIGHT UP |
| WET BULB TEMP | WB | °F | INSTEP | SLANTED |
| SPECIFIC HUMIDITY | W | GR/LB | HEEL RIGHT VERT | HORIZONTAL TO RIGHT |
| DEW POINT TEMP | DP | °F | INSTEP | HORIZONTAL TO LEFT |
| RELATIVE HUMIDITY | RH | %RH | CURVED | CURVED |
| SPECIFIC VOLUME | V | FT³/LB | STEEPLY SLANTED | STEEPLY SLANTED |
| | | | | |

Seven Properties of Air...

7. Enthalpy

- Total amount of heat energy (sensible and latent) in one pound of air.



| PROPERTY OF AIR | SYMBOL | EXPRESSED BY | SCALE LOCATION | LINE DRAWN |
|-------------------|--------|-------------------------|-----------------|----------------------|
| DRY BULB TEMP | DB | $^{\circ}\text{F}$ | SOLE BOTTOM | STRAIGHT UP |
| WET BULB TEMP | WB | $^{\circ}\text{F}$ | INSTEP | SLANTED |
| SPECIFIC HUMIDITY | W | GR/LB | HEEL RIGHT VERT | HORIZONTAL TO RIGHT |
| DEW POINT TEMP | DP | $^{\circ}\text{F}$ | INSTEP | HORIZONTAL TO LEFT |
| RELATIVE HUMIDITY | RH | %RH | CURVED | CURVED |
| SPECIFIC VOLUME | V | FT^3/LB | STEEPLY SLANTED | STEEPLY SLANTED |
| ENTHALPY | H | BTU/LB | ABOVE INSTEP | EXTENSION OF WB LINE |

PSYCHROMETRIC ASSIGNMENT

Prof. Koldenhott suggests that you do the following Assignment:

1. Print multiple copies of the next slide (Psychrometric Chart.)
2. Using a Sling Psychrometer, record Outdoor Conditions and Indoor Conditions. (Note: Instruction on how to construct a sling psychrometer follows the next slide.)
3. Plot the Outdoor conditions (DB and WB) on one Psychrometric Chart.
 1. Plot the Indoor conditions (DB and WB) on one Psychrometric Chart.
 2. Draw the lines necessary to find all other Properties of air

DB TEMP: _____ NOTE: USE PROPER UNITS.

WB TEMP: _____

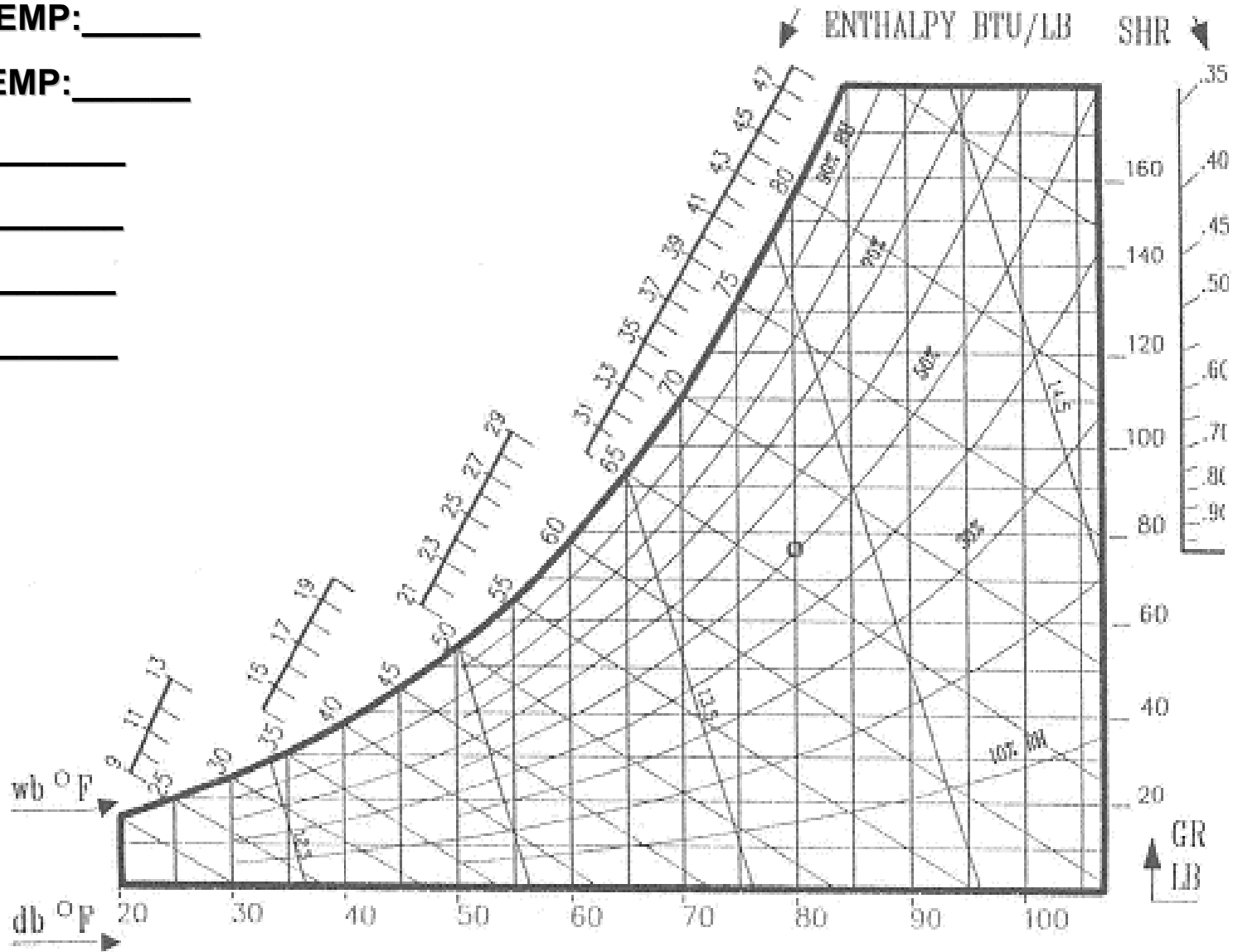
DP TEMP: _____

W: _____

RH: _____

V: _____

H: _____

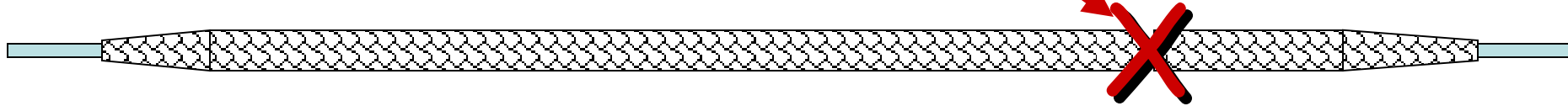


Making a Sling Psychrometer for reading WB:

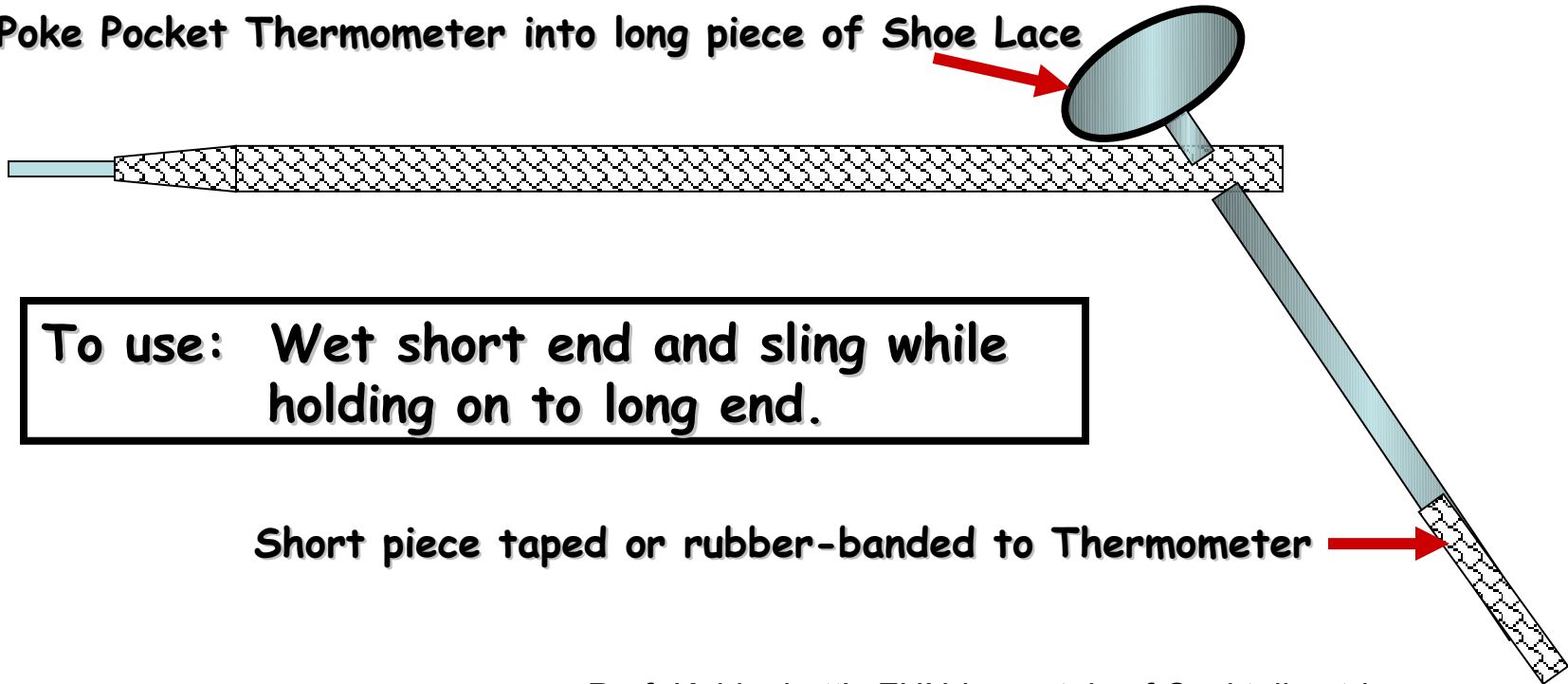
WB: Need: 1 ea. Athletic Shoe Lace



Cut Shoe Lace



Poke Pocket Thermometer into long piece of Shoe Lace

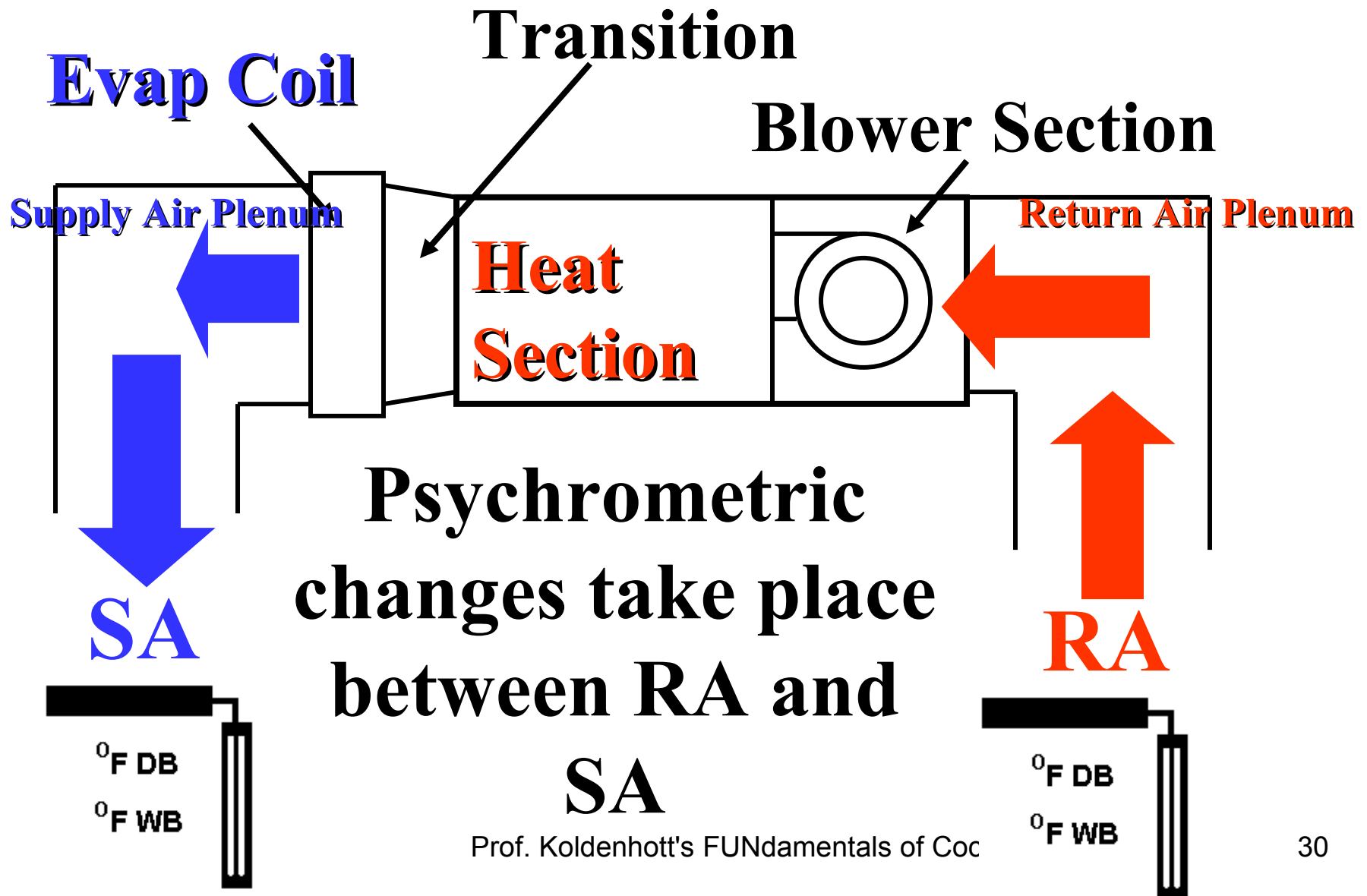


To use: Wet short end and sling while holding on to long end.

Short piece taped or rubber-banded to Thermometer

Air Conditioning Processes

Air Conditioning Processes...



Heating only

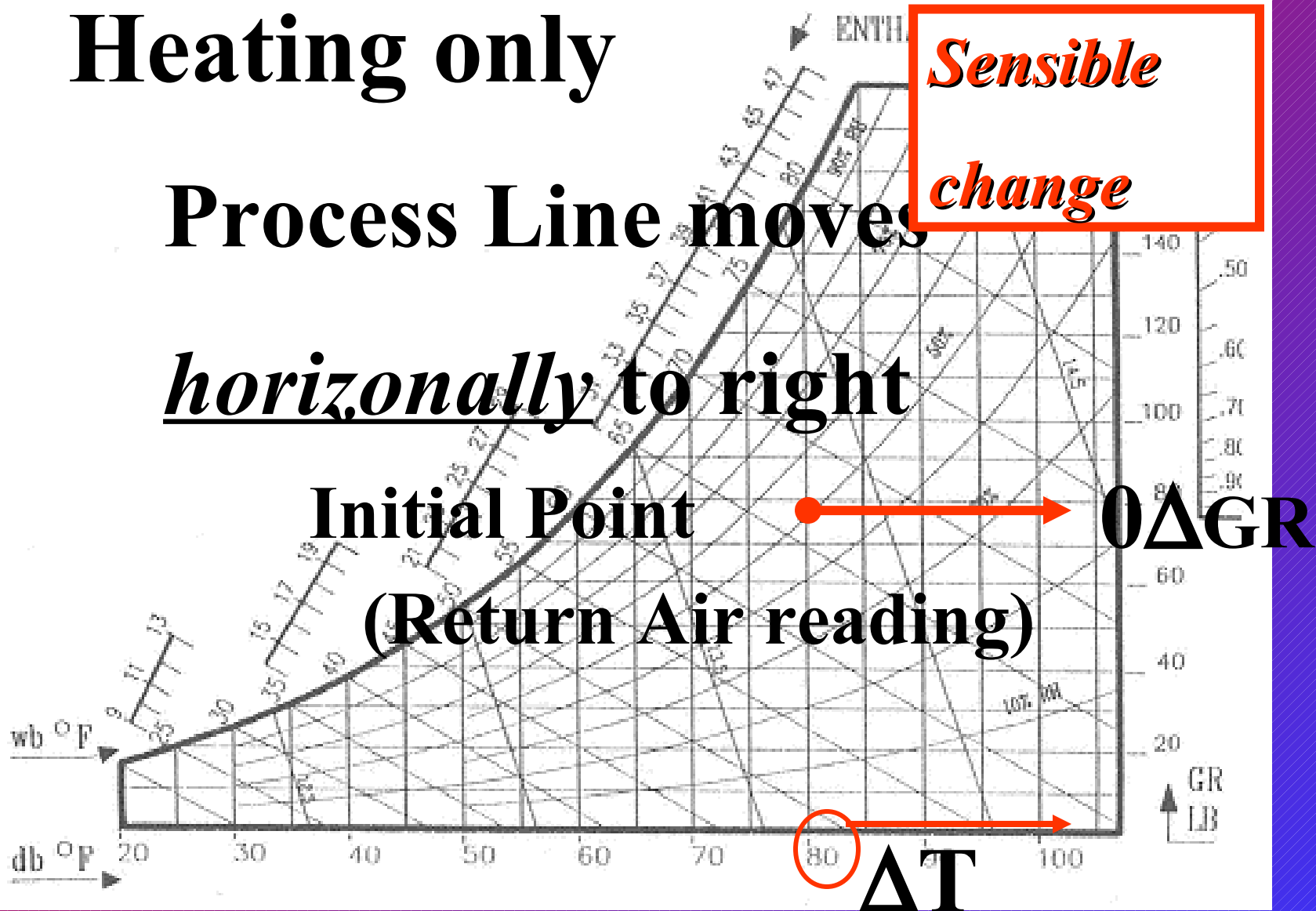
Process Line moves

horizontally to right

Initial Point

(Return Air reading)

*Sensible
change*

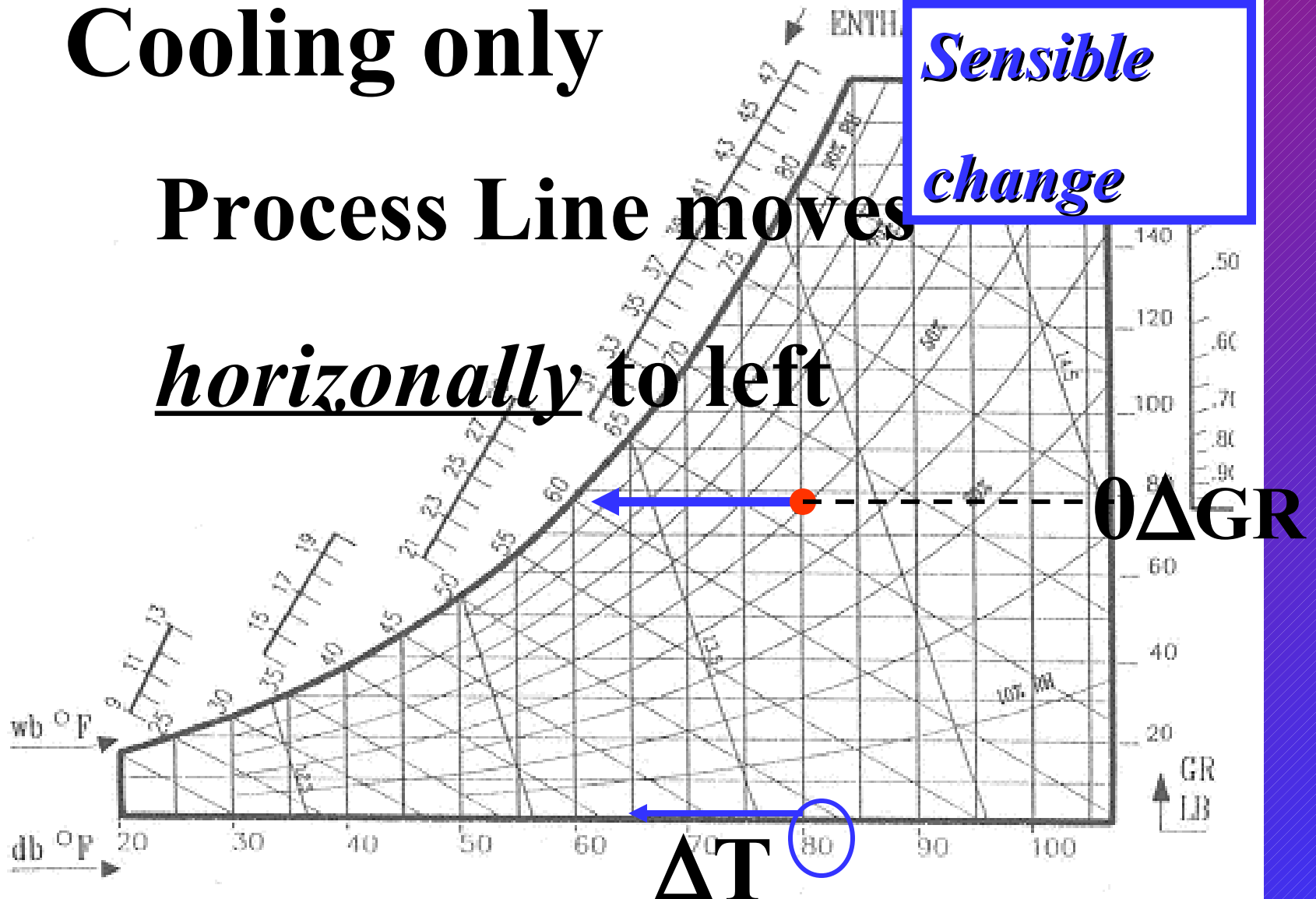


Cooling only

Process Line moves

horizontally to left

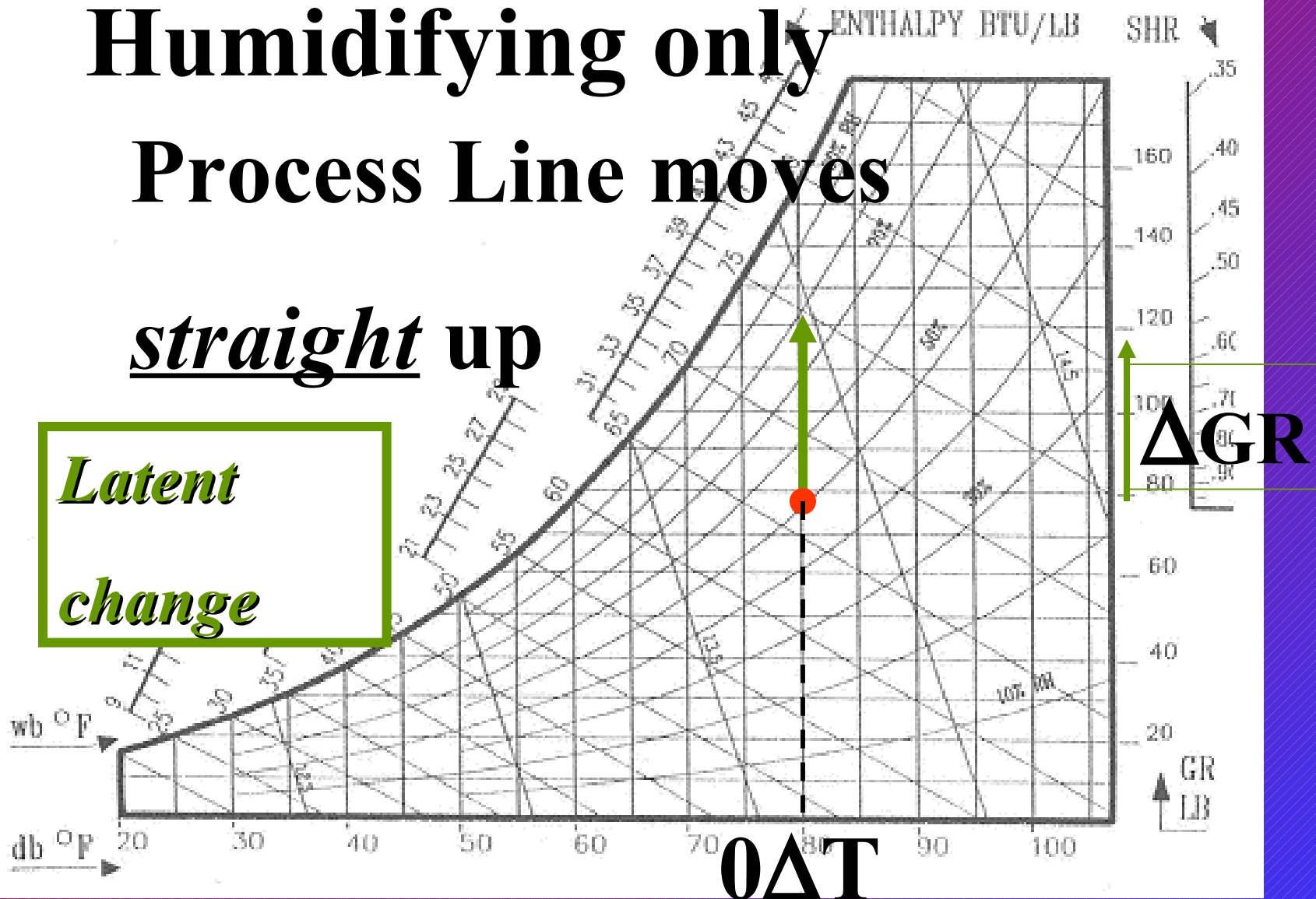
*Sensible
change*



Humidifying only Process Line moves

straight up

*Latent
change*

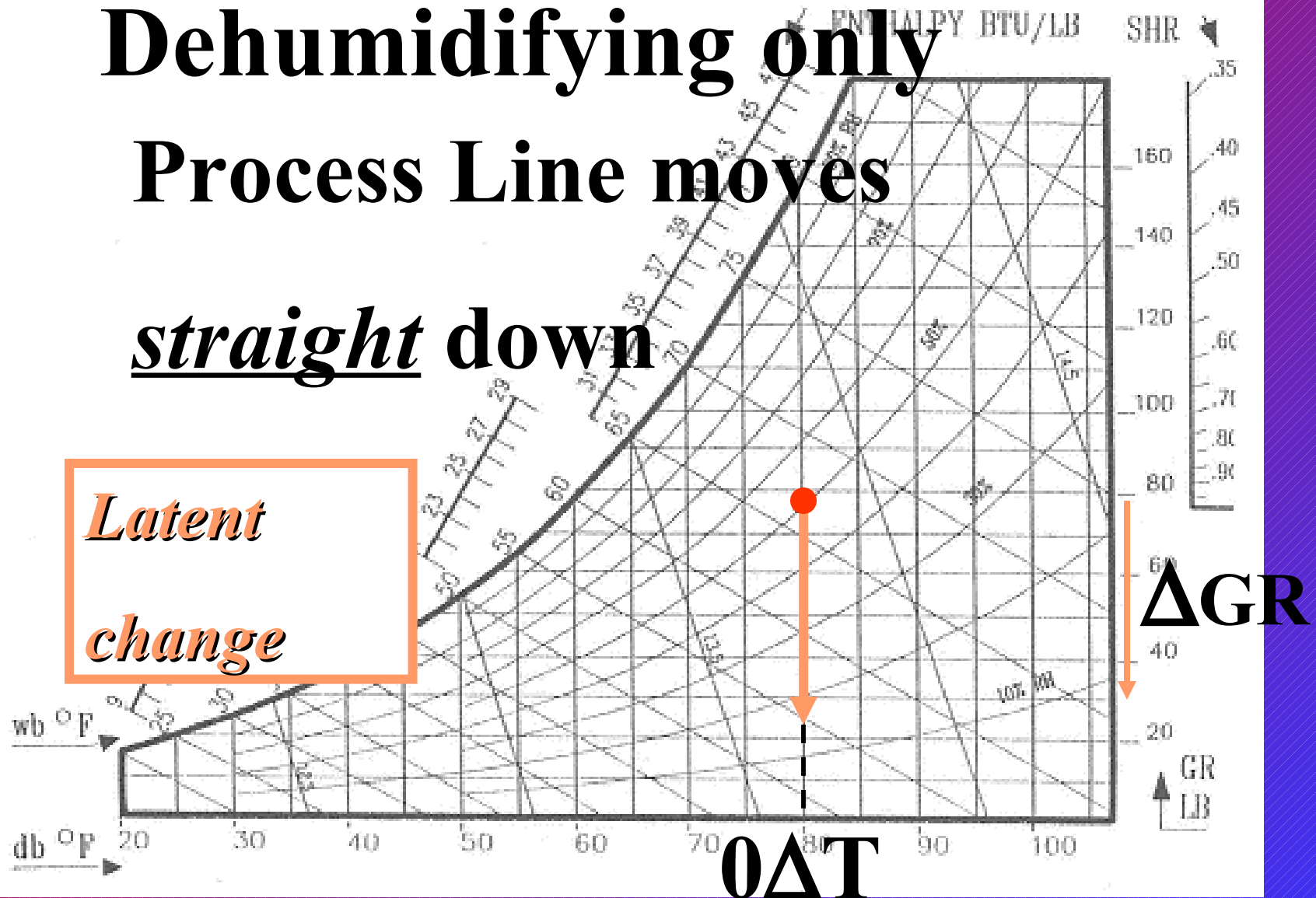


Dehumidifying only

Process Line moves

straight down

*Latent
change*



Other AC Processes...

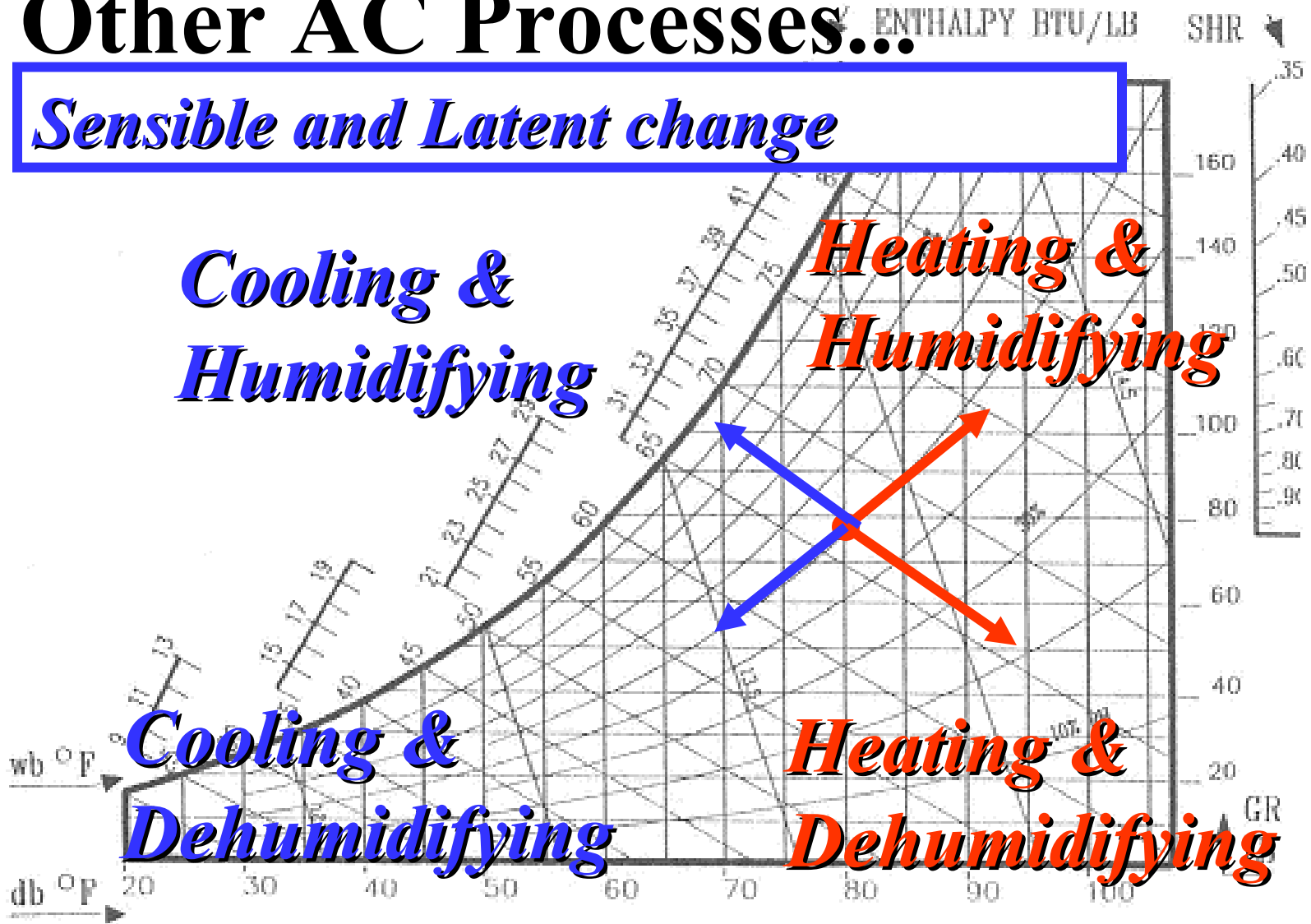
Sensible and Latent change

Cooling & Humidifying

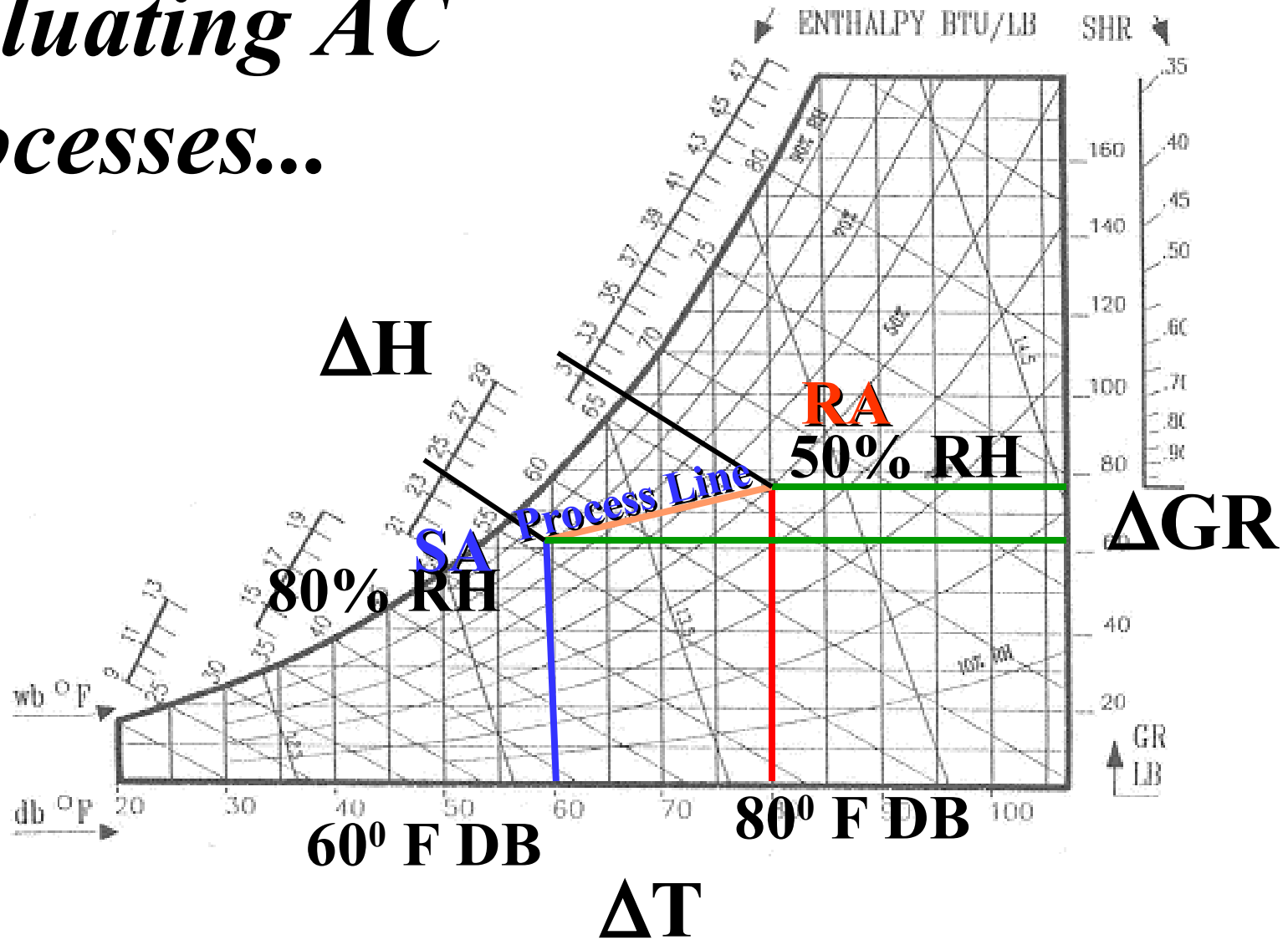
Heating & Humidifying

Cooling & Dehumidifying

Heating & Dehumidifying



What we need for evaluating AC Processes...



Air Side Equations

Sensible Load:

$$Q_s = 1.1 \times \text{CFM} \times \Delta T$$

A constant based on the Density of Air and a time conversion factor

Determined from the Condensing Unit model number

Q_s is expressed in BTUH

Air Side Equations

Latent Load:

$$Q_L = .68 \times \text{CFM} \times \Delta GR$$

**A constant...
including a time
conversion factor**

**Same as that used
for Q_s**

Q_L is expressed in BTUH

Air Side Equations

Total Load:

$$Q_T = 4.45 \times \text{CFM} \times \Delta H$$

**A constant...
including a time
conversion factor**

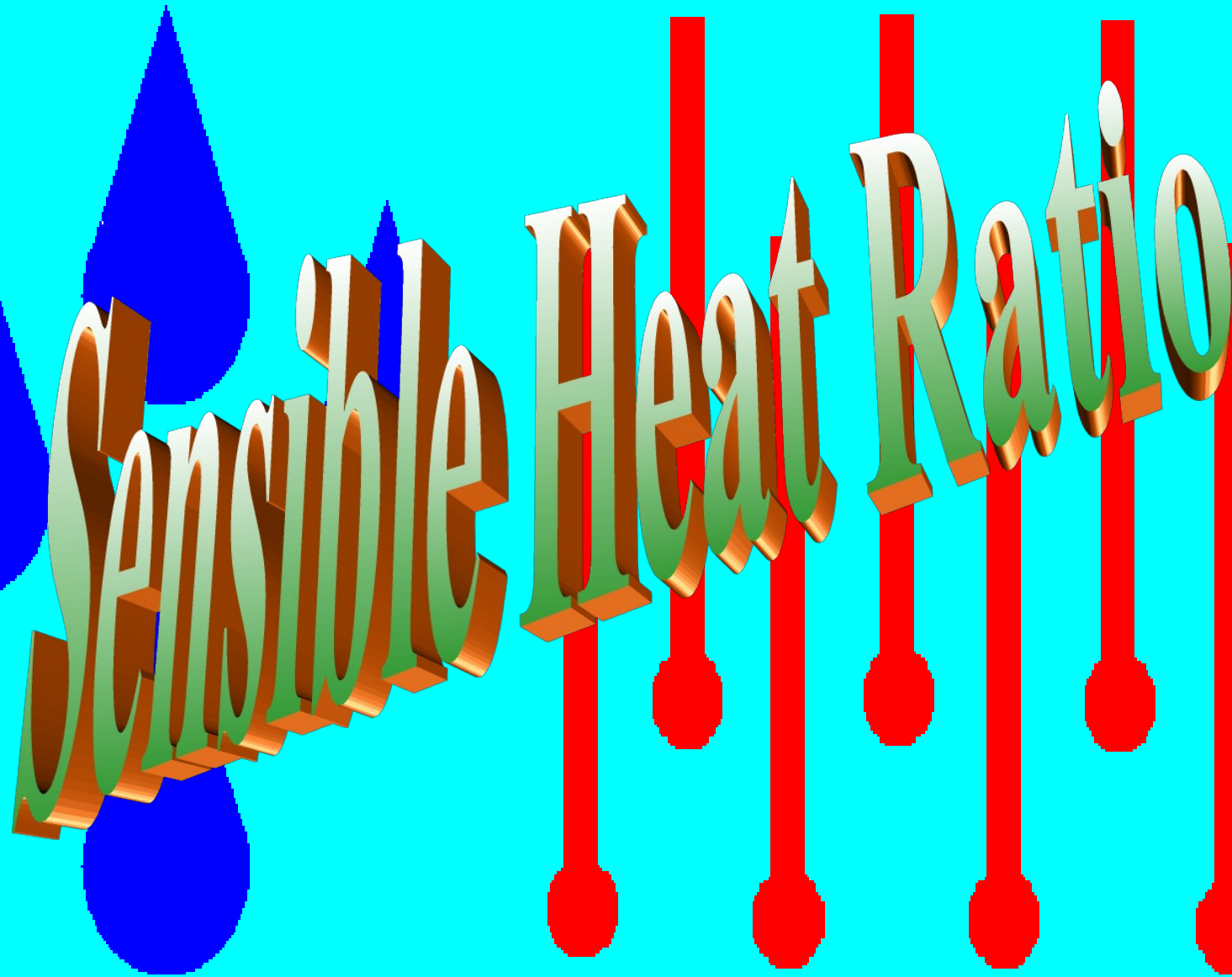
**Same as that used
for Q_s**

Q_T is expressed in BTUH

PSYCHROMETRIC PROCESSES ASSIGNMENT

Prof. Koldenhott suggests that you do the following Assignment:

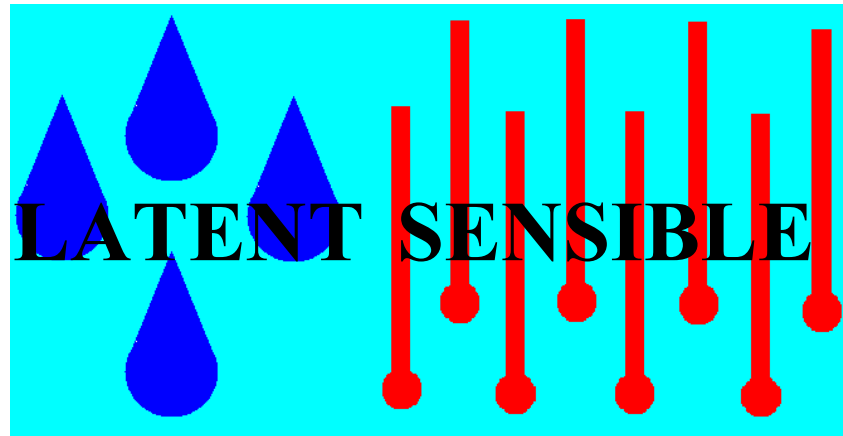
1. Using a Sling Psychrometer, record **Return Air** Condition and **Supply Air** Condition of an actual Air Conditioning Process (suggest Cooling and Dehumidification for best results.) **Determine CFM from Model # of Outdoor Unit.** Plot the RA and SA on the chart.
1. Draw the Process Line. What type of Psychrometric Process? _____
2. Determine ΔT : _____, ΔGR : _____ ΔH : _____
4. Calculate:
 - a. Q_S : _____
 - b. Q_L : _____
 - c. Q_T : _____



The image features the text "Sensible Heat Ratio" in a large, 3D, metallic font. The word "Sensible" is on the left, and "Heat Ratio" is on the right. The text is set against a light blue background. To the left of the text are four blue water droplets of varying sizes. To the right of the text are seven vertical red bars of varying heights, each ending in a red circular base. The overall composition is stylized and graphic.

Sensible Heat Ratio

Sensible Heat Ratio...



*...the ratio of Sensible Load
(Q_s) to Total Load (Q_T)*

Sensible Heat Ratio...

$$\text{SHR} = \frac{Q_s}{Q_T}$$

Sensible Heat Ratio...

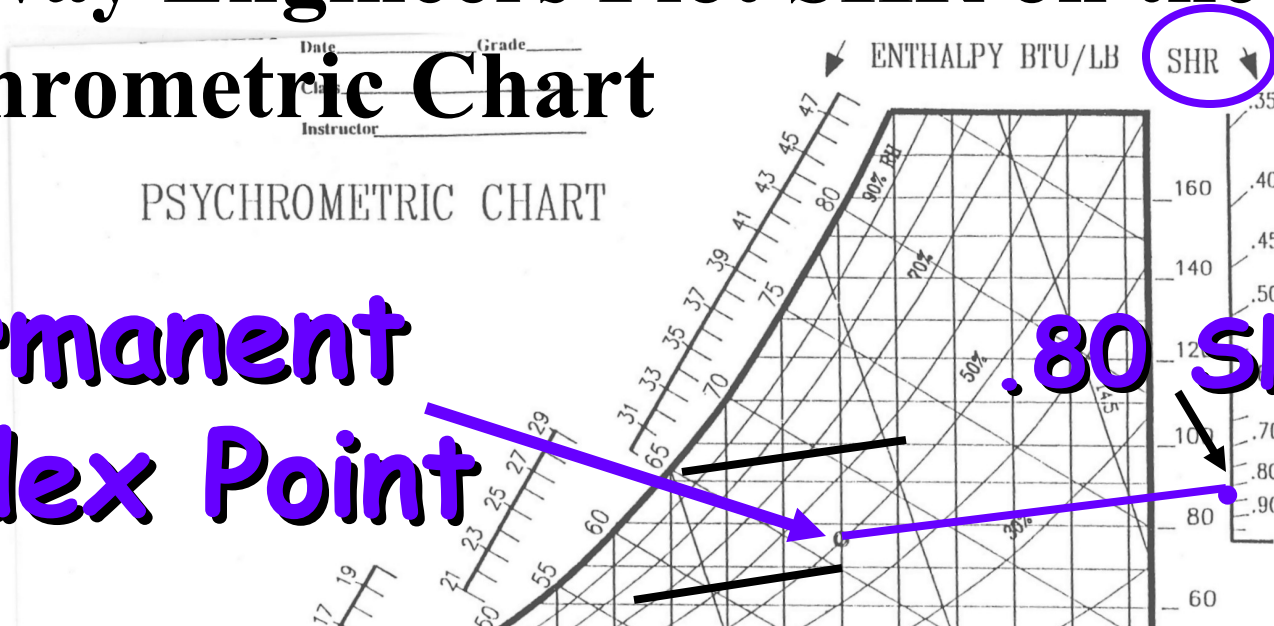
Example:

$$\text{SHR} = \frac{29,060 \text{ btuh}}{36,325 \text{ btuh}} =$$

.80 SHR

Sensible Heat Ratio...

The way Engineers Plot SHR on the Psychrometric Chart



**Permanent
Index Point**

**Note: Any Process Line
parallel to this line will
maintain the SHR**

SENSIBLE HEAT RATIO ASSIGNMENT

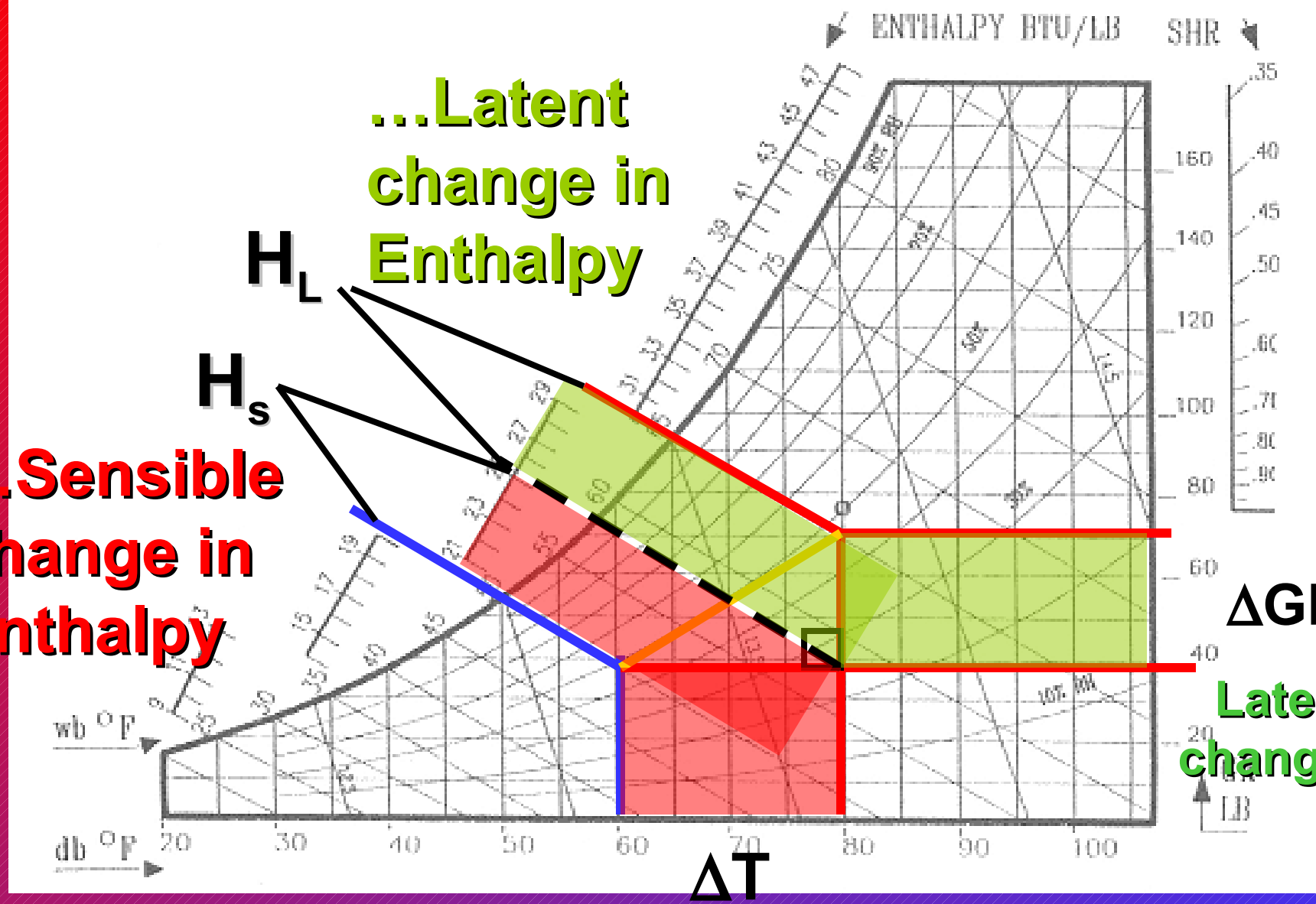
Prof. Koldenhott suggests that you do the following Assignment:

Calculate Actual Sensible Heat Ratio for the previous assignment.

Sensible & Latent Changes in Enthalpy

...Sensible
change in
Enthalpy

...Latent
change in
Enthalpy



ΔGR
Latent
change...

If you've gone through the entire presentation, I appreciate your effort. Please let me know what you think.

Prof. Koldenhott
AIR CONDITIONING INSTRUCTOR

Email: profkoldenhott@tx.rr.com

or write:

Prof. Koldenhott
2787 Sun Valley Dr.
Grand Prairie, Texas 75052