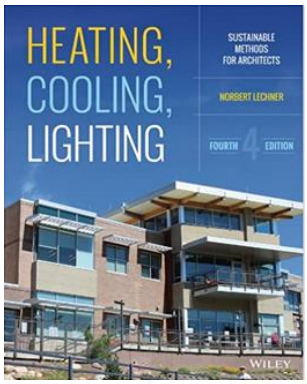
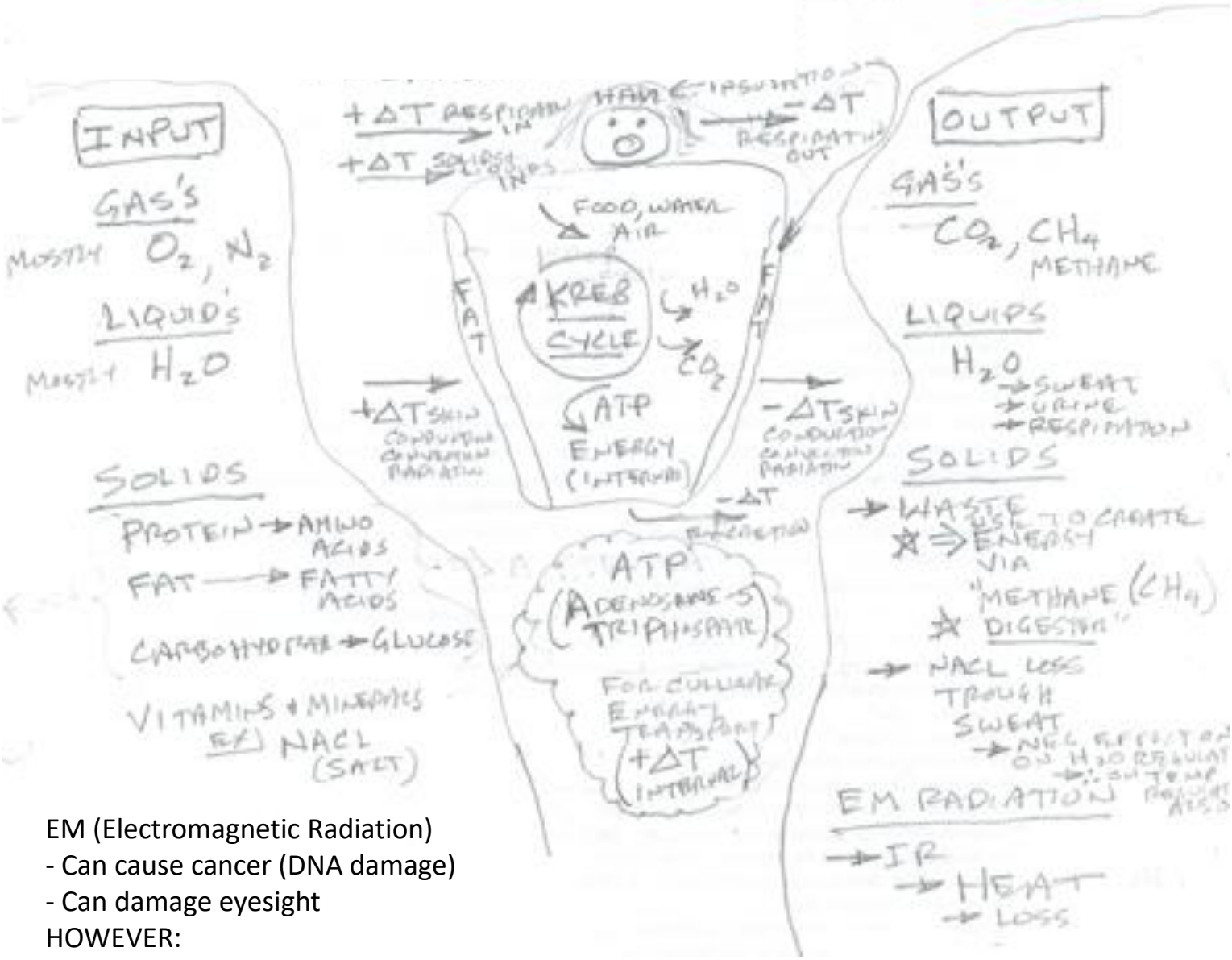
A&E COMFORT, *and health*



EGR343 Green Architectural Engineering Lecture Notes Chapter 4



EM (Electromagnetic Radiation)
- Can cause cancer (DNA damage)
- Can damage eyesight

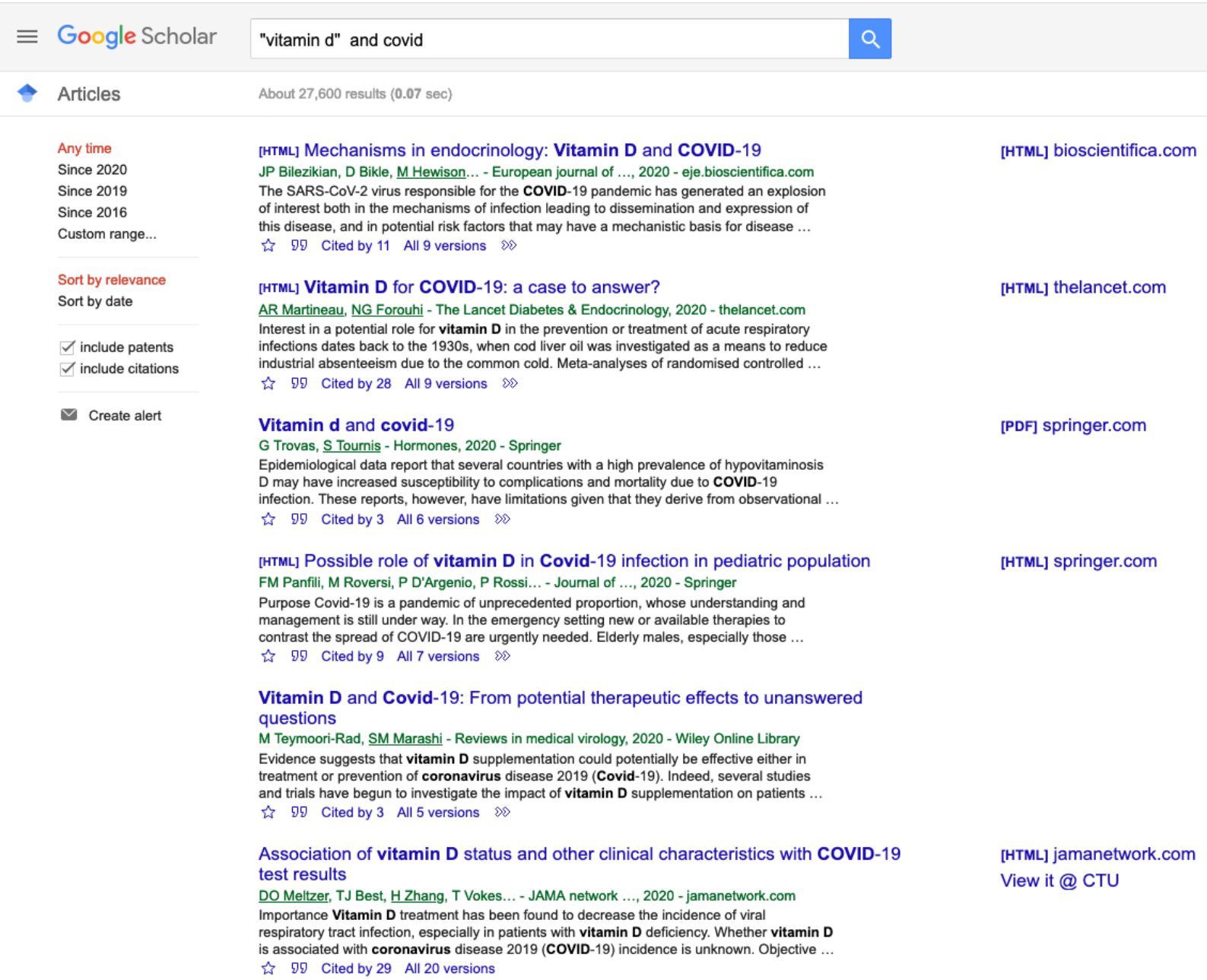
HOWEVER:
+ UV-C can kill EBOLA! … and COVID?
+ UV made into Vitamin D by body's skin
COULD MAYBE help prevent COVID infection and Mortality

EM (Electromagnetic Radiation)

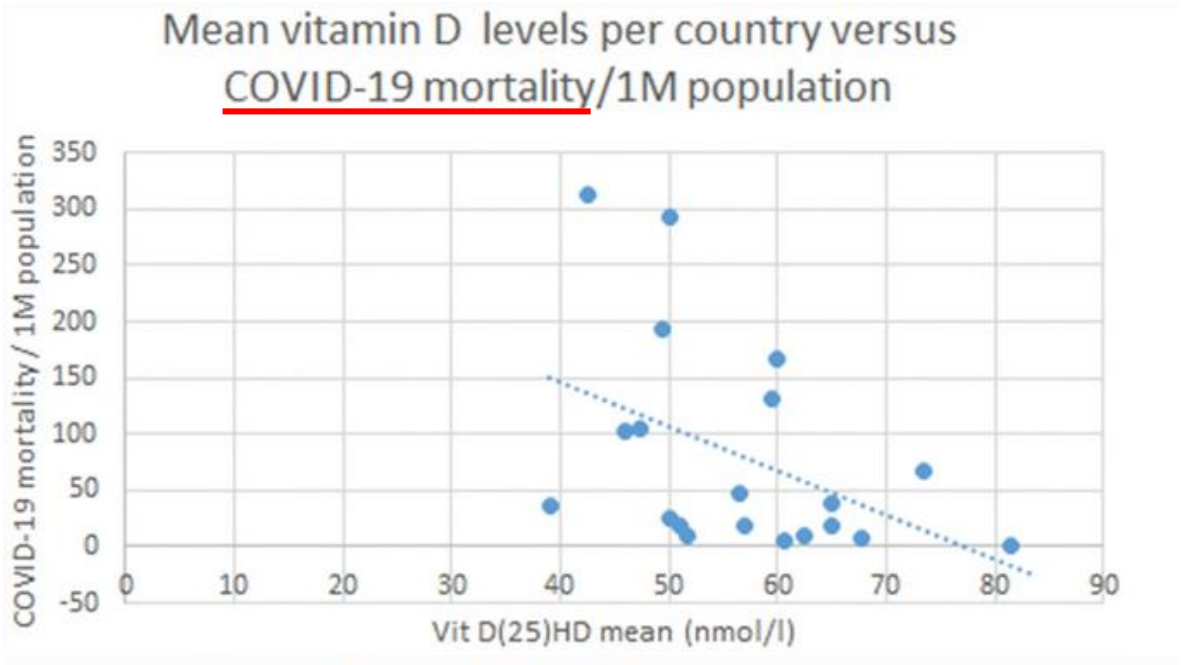
+ UV made into Vitamin D by body's skin *COULD* ***MAYBE*** help prevent COVID infection and Mortality

2020 research is ongoing !! -- look for PEER-REVIEWED publications from SCHOLARLY SOURCES:

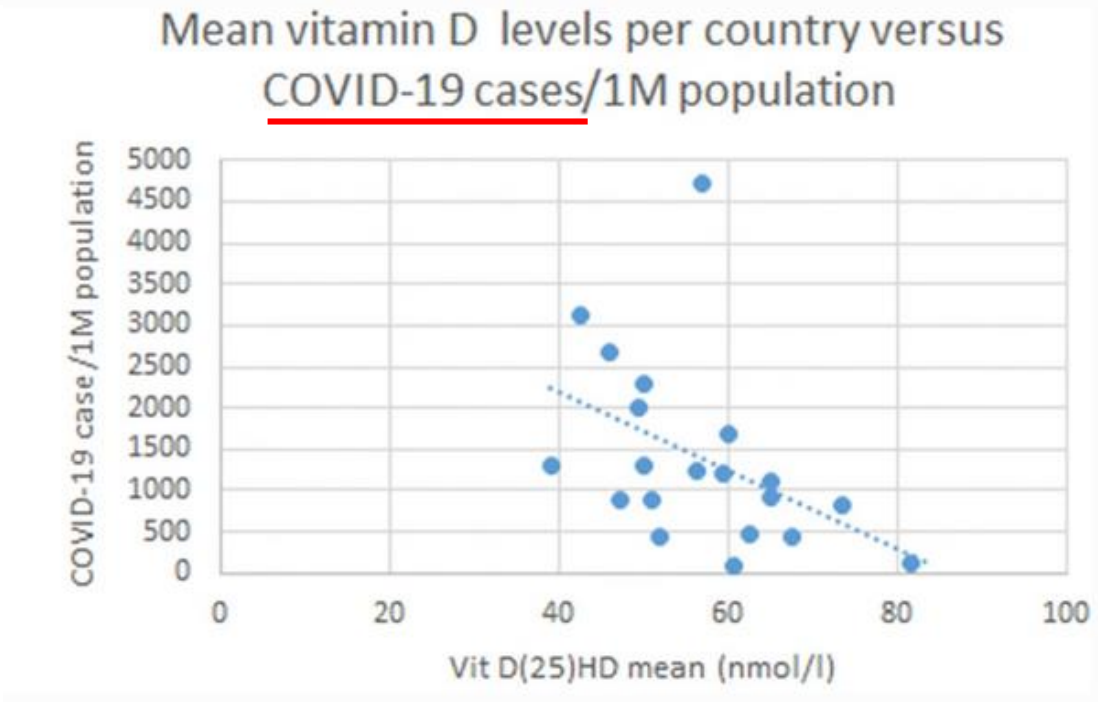
https://scholar.google.com/scholar?hl=en&as_sdt=0,39&q=%22vitamin+d%22++and+covid



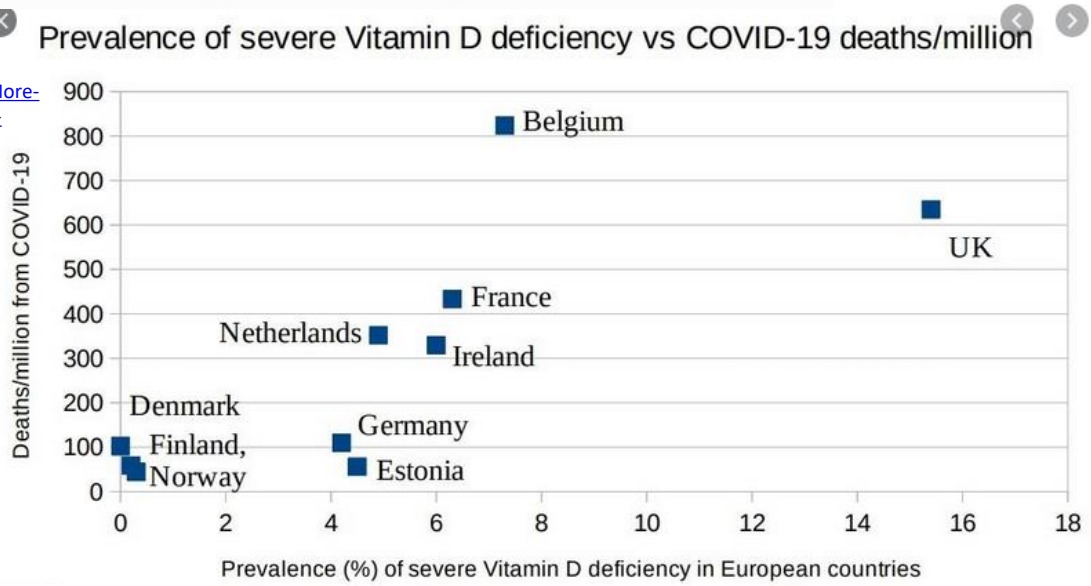
EM (Electromagnetic Radiation)
+ UV made into Vitamin D by body's skin *COULD* ***MAYBE*** help prevent COVID infection and Mortality



https://link.springer.com/article/10.1007/s40520-020-01570-8/figures/1



https://www.news-medical.net/news/20200702/More-evidence-on-vitamin-D-deficiency-and-death-rates-from-COVID-19.aspx

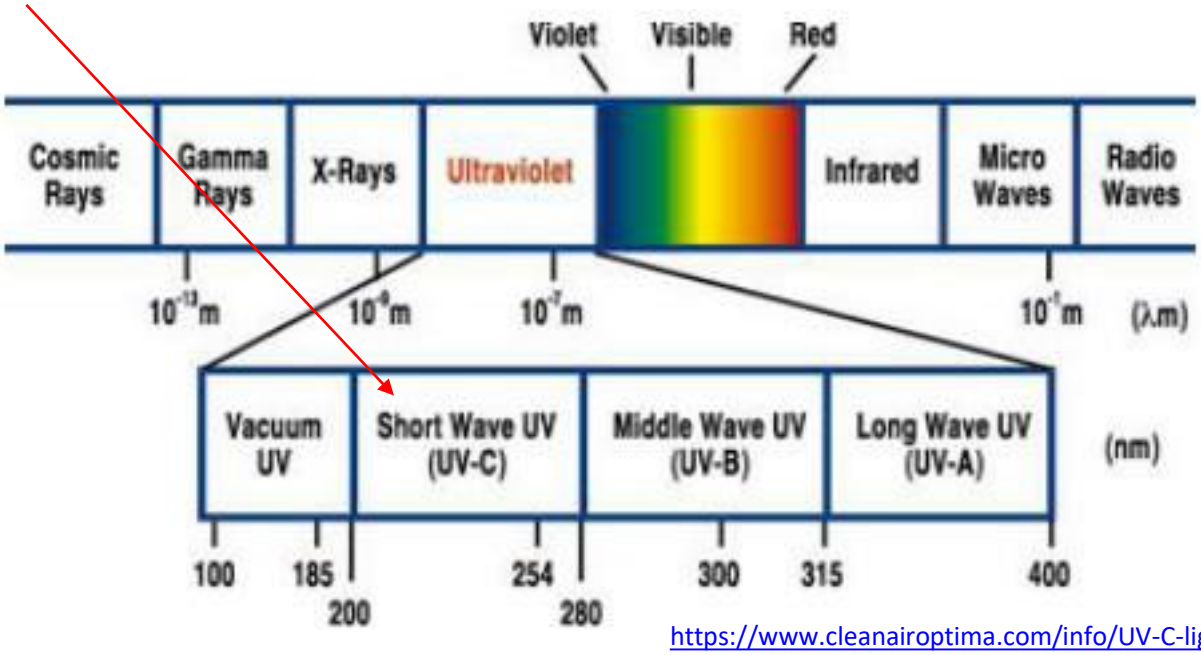


JT Wunderlich PhD

1097 × 606

EM (Electromagnetic Radiation)

+ "**UV-C DISINFECTION"** can kill EBOLA! … and COVID?



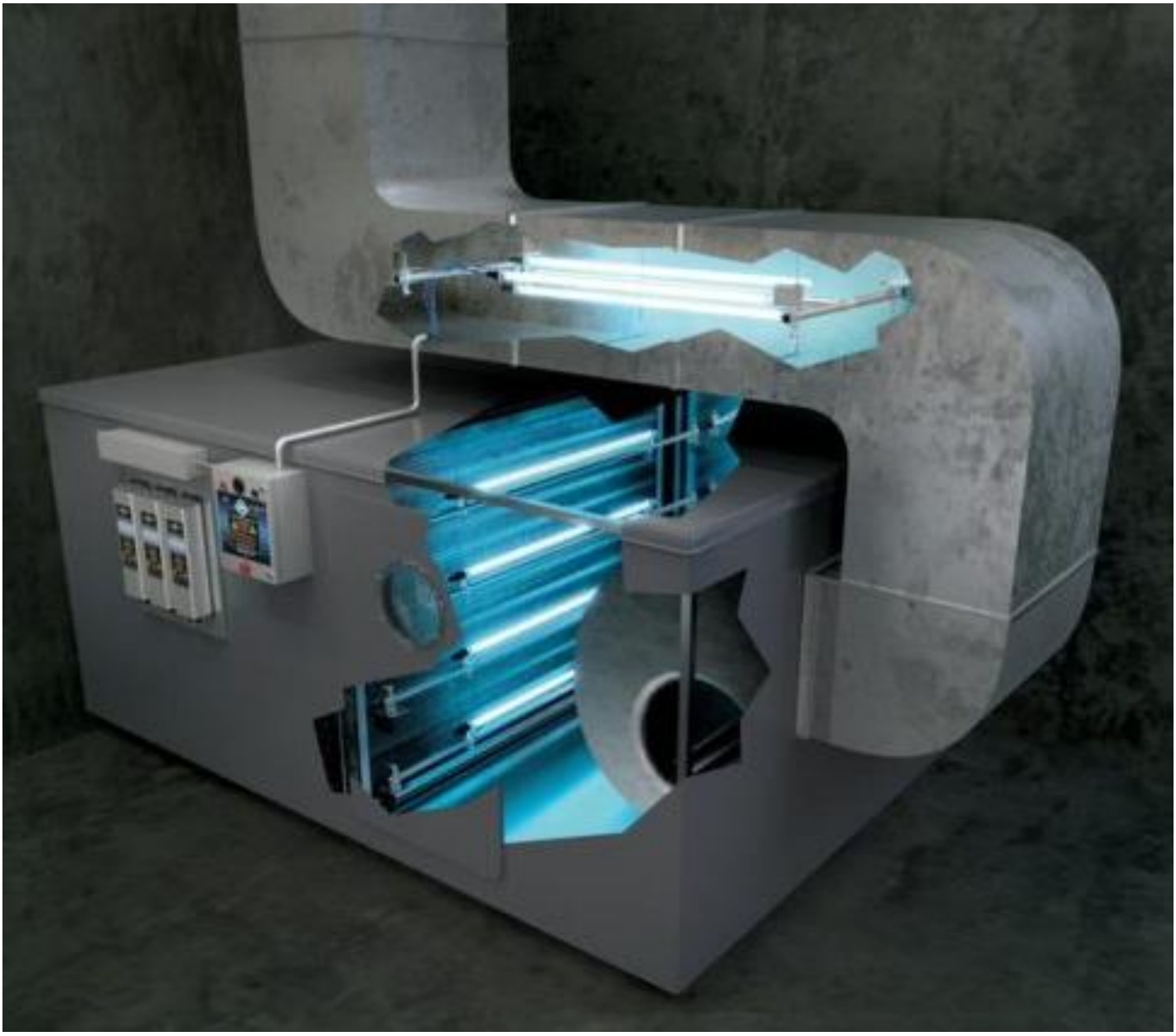
https://www.cleanairoptima.com/info/UV-C-light/

From JT Wunderlich lecture:

"HUMANITY?; Human Computer Interaction (HCI), it's mostly good"

- PDF
- Listen outside of class time: PPTX-w/Audio MP4 YouTube

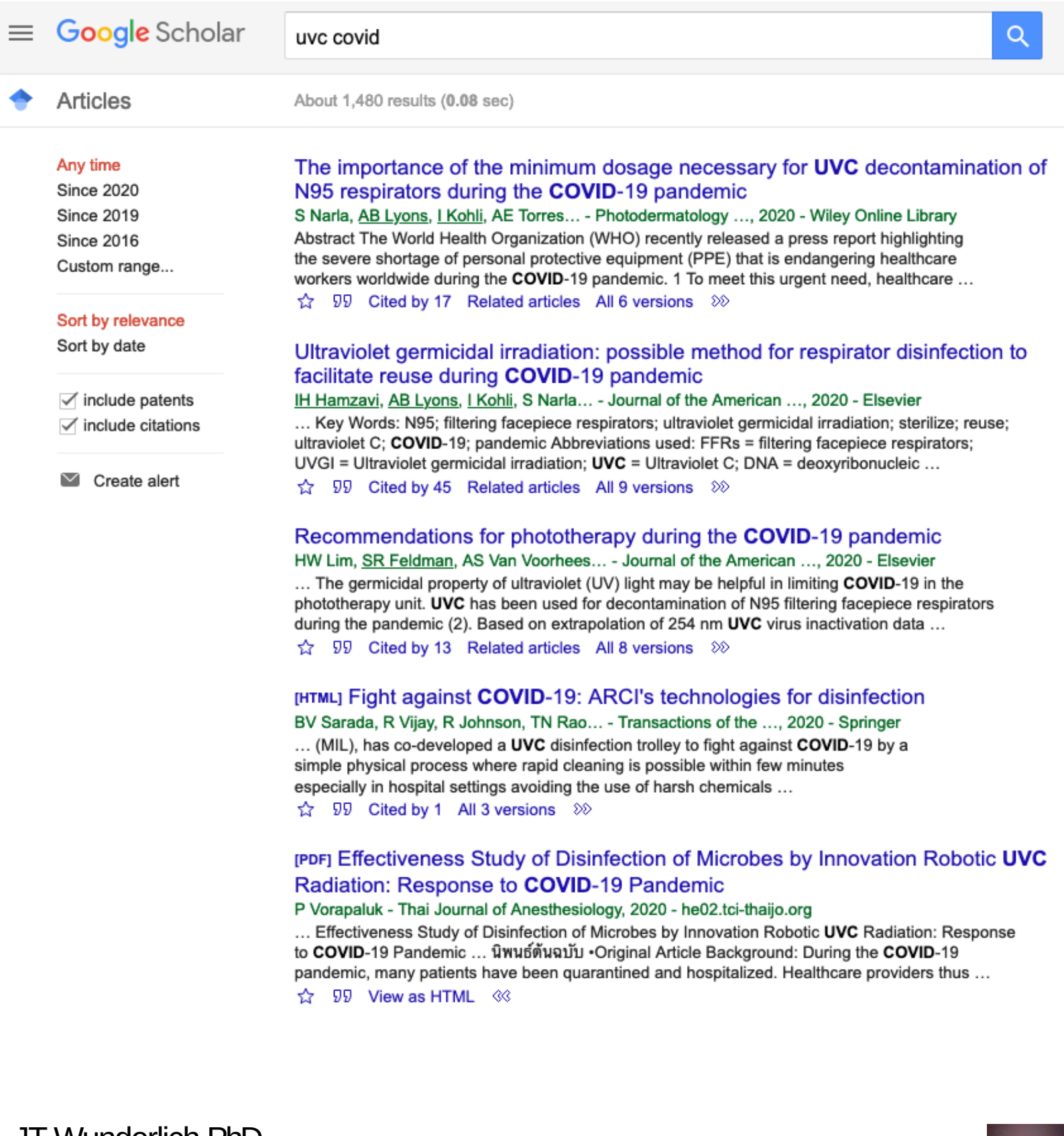
EM (Electromagnetic Radiation)
+ “**UV-C DISINFECTION”** can kill EBOLA! … and COVID?



https://www.achrnews.com/articles/143318-covid-19-reveals-importance-of-uv-c-in-hvac-industry?v=preview

EM (Electromagnetic Radiation)
+ "**UV-C DISINFECTION**" can kill COVID-19 ??
As of October 2, 2020:

https://scholar.google.com/scholar?hl=en&as_sdt=0%2C39&q=uvc+covid&btnG=



JT Wunderlich PhD

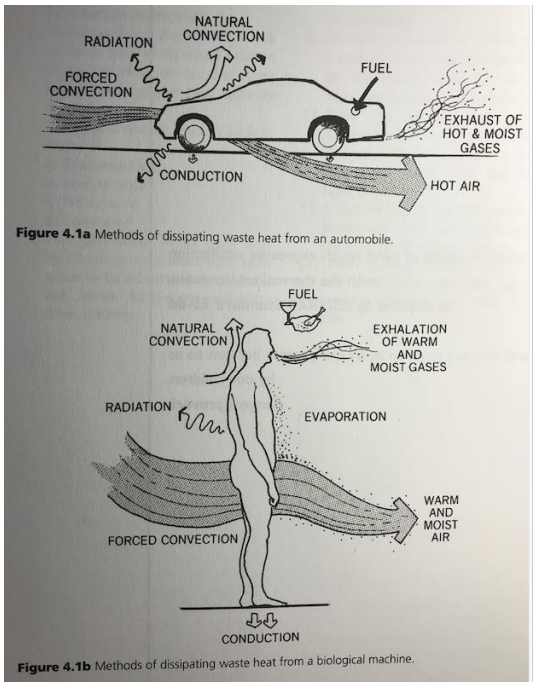


Figure 4.1a Methods of dissipating waste heat from an automobile.

Figure 4.1b Methods of dissipating waste heat from a biological machine.

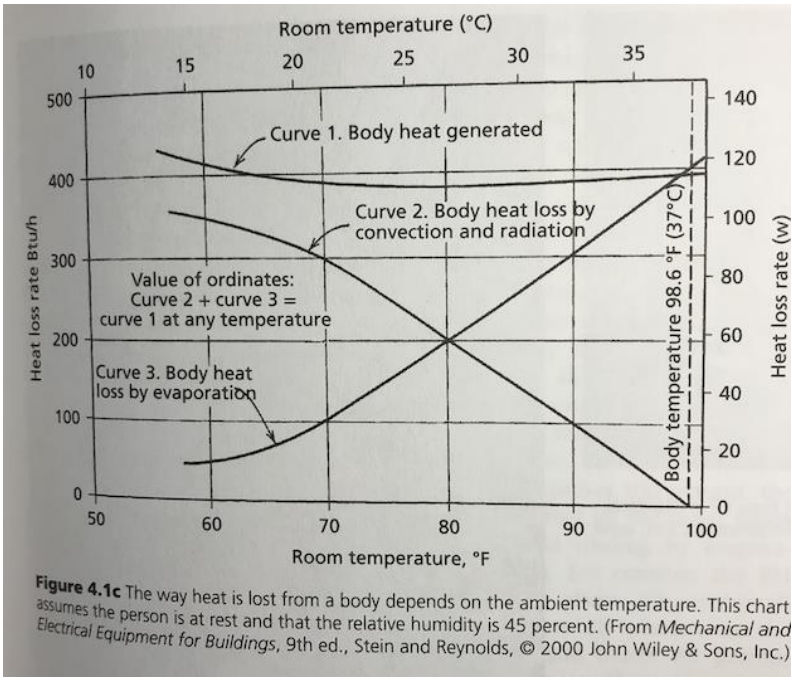
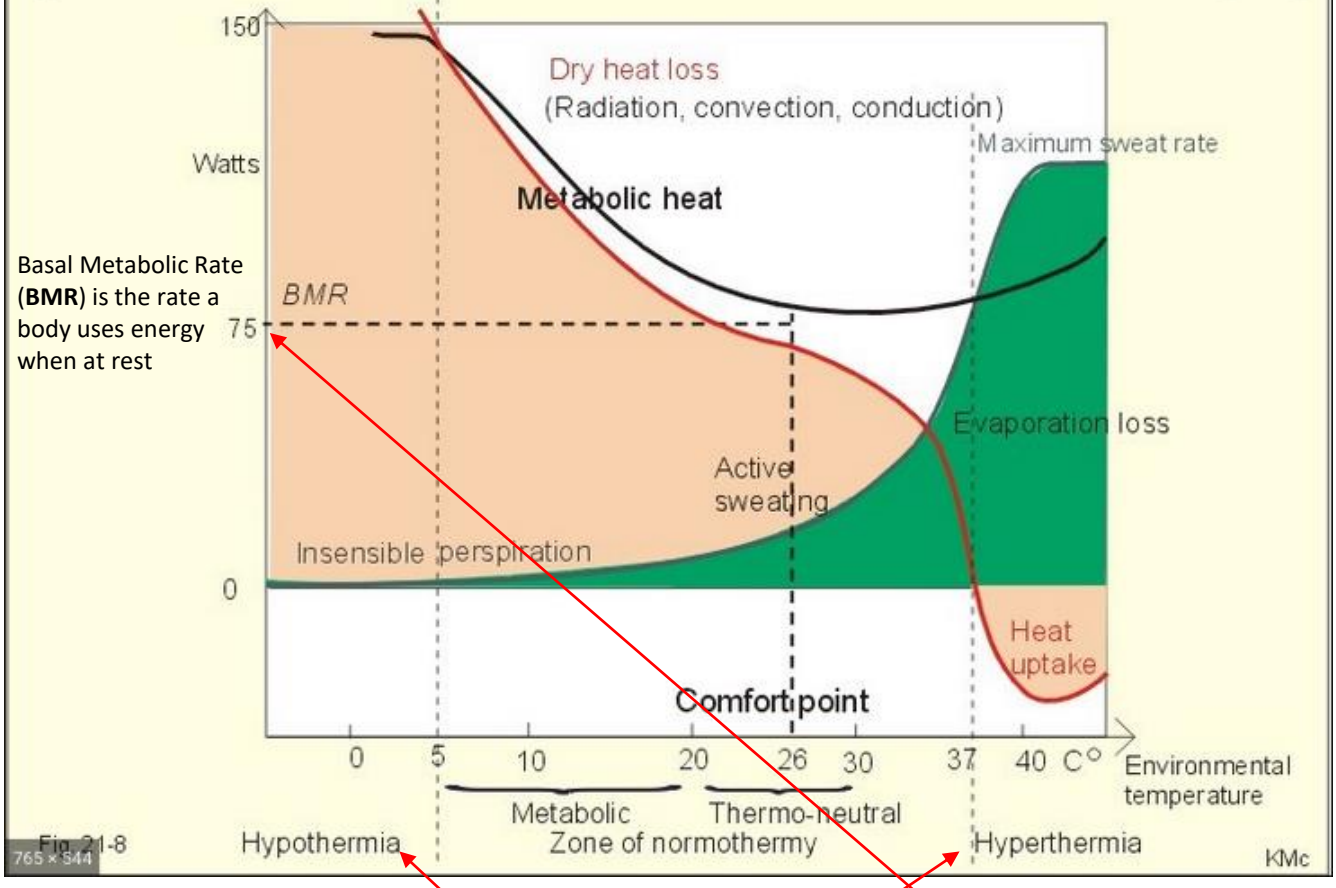


Figure 4.1c The way heat is lost from a body depends on the ambient temperature. This chart assumes the person is at rest and that the relative humidity is 45 percent. (From *Mechanical and Electrical Equipment for Buildings*, 9th ed., Stein and Reynolds, © 2000 John Wiley & Sons, Inc.)

1 Watt= 3.41 **BTU**/h



Basal Metabolic Rate (**BMR**) is the rate a body uses energy when at rest

Fig. 21-8: Metabolic rate and environmental temperature in a fasting dressed human at rest. The wet and the dry heat loss, as well as the metabolic heat and the basal metabolic rate (*BMR*) is measured in Watts.

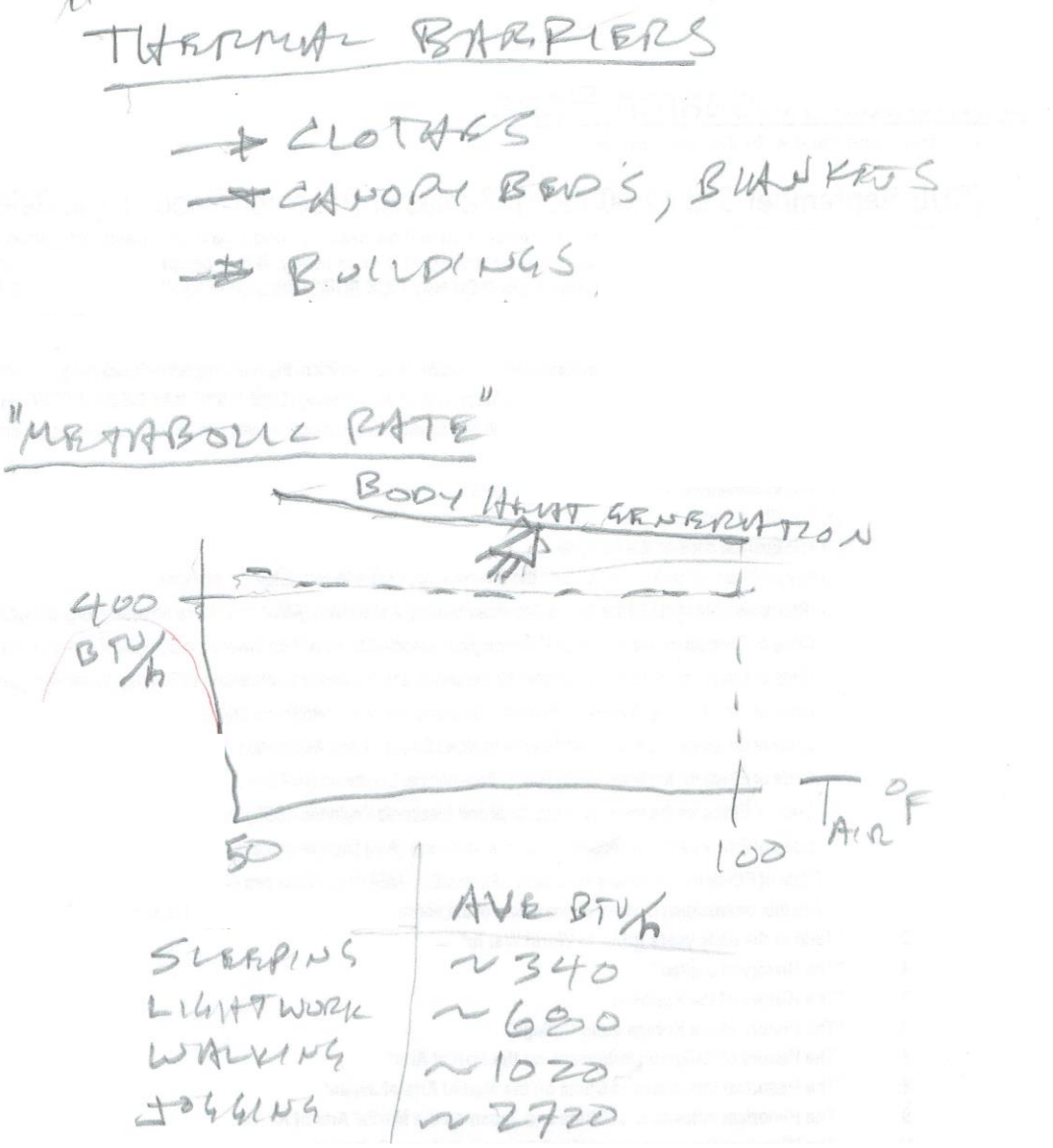
For a Body at rest

In the *metabolic zone*, the total heat loss rises with falling environmental temperature, but below 5 °C in the environment, the dry heat loss exceeds the metabolic rate, and the body is cooled down (**Fig. 21-8**). This is the *zone of hypothermia*, where cold death is inevitable without treatment.

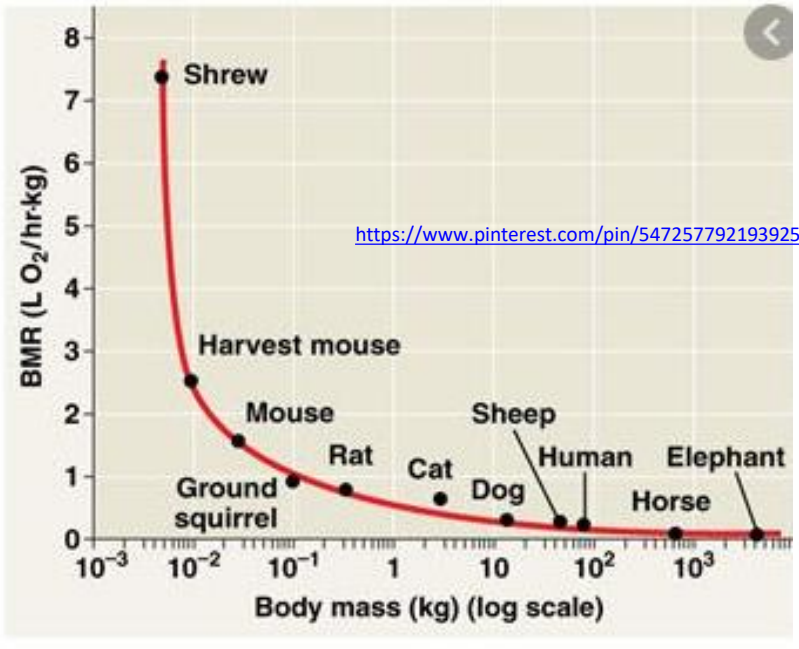
The *zone of hyperthermia* begins at an environmental temperature of 37 °C, where humans soon reach the maximal capacity for evaporation and there is an unbalanced heat influx to the body ending in *heat death*.

https://www.zuniv.net/physiology/book/chapter21

JT Wunderlich PhD



Basal Metabolic Rate (**BMR**) is the rate a body uses energy when at rest



(b) Relationship of BMR per kilogram of body mass to body size

JT Wunderlich PhD

"THERMAL CONDITIONS OF ENVIRONMENT

① AMBIENT AIR TEMP T_{AIR}

Rate of Change of Body Temp with respect to change in time, due to Ambient Air Temp

$$\frac{dT_{BODY}}{dt_{TIME}} = f(T_{AIR})$$

② RELATIVE HUMIDITY RH

Rate of Change of Body Temp with respect to change in time, due to Ambient Relative Humidity, AND evaporation of Sweat off of body

$$\left(\frac{dT_{BODY}}{dt}\right)_{EVAPORATION} = f(RH)$$

~ COMFORT @:

RH_{SUMMER} = ~20 TO 60 ★

RH_{WINTER} = ~20 TO 80 ★

@ LOW RH:

★ → DRY NOSE, MOUTH, SKIN, EYES

★ → RESPITORY ILLNESS

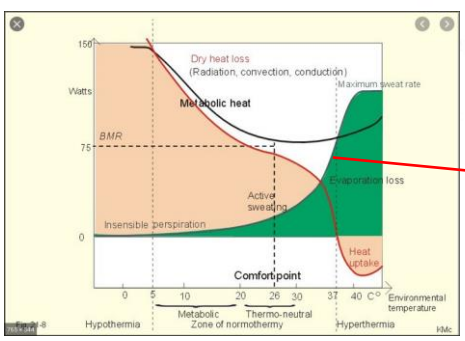
→ STATIC ELECTRICITY

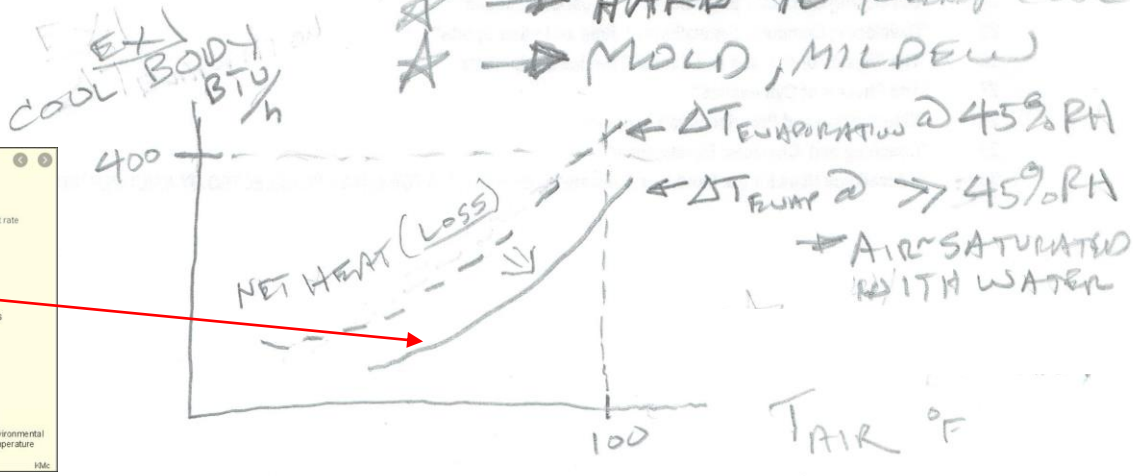
★ → WOOD SHRINKAGE

@ HIGH RH:

★ → HARD TO KEEP COOL

★ → MOLD, MILDEW





"AIR MOVEMENT"

$\Delta T_{BODY} = f$(CONVECTION, EVAPORATION)

→ GOOD IN SUMMER

→ BAD IN WINTER

★ → DRAFTS → DON'T PUT BED IN DRAFT

★ → "WIND CHILL FACTOR"

SEE CHAPTER 3 → MRT (MEAN RADIANT TEMP)

COMFORT = f(PROXIMITY TO SOURCES)

★ → BEST IF HEAT SOURCE ALLOWS EVEN DISTRIBUTION THROUGHOUT HOUSE

★ →
- → HOT-WATER-LOOP RADIATORS
- → RADIANT FLOOR HEATING
- → NOT POT-BELLY STOVES OR ELECTRIC WIRE HEATERS

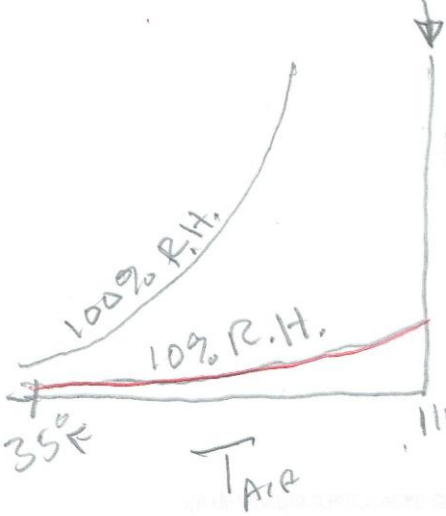
★ → DON'T PUT BED UNDER WINDOW IN COLD CLIMATES

"PSYCHOMETRIC CHART"

SPECIFIC HUMIDITY (HUMIDITY RATIO)

★ → ACTUAL AMOUNT OF WATER IN AIR

= f(TEMP)



RELATIVE HUMIDITY (RH)

= f(TEMP, MAX H_2O AIR CAN HOLD AT THAT TEMP)

★ → @ 100% RH SWEAT CAN'T EVAPORATE

PSYCHOMETRIC CHARTS

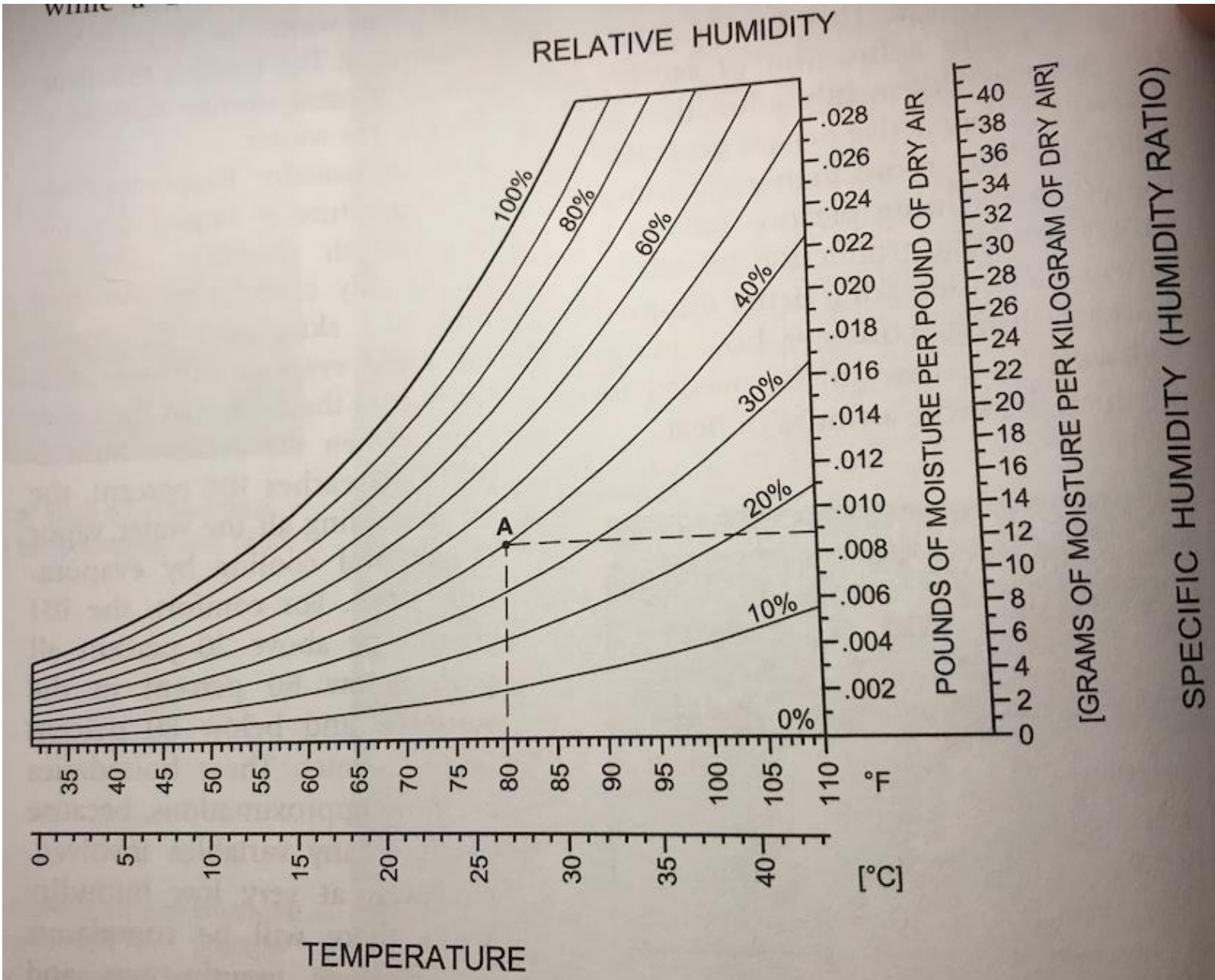


Figure 4.5a Each point on the psychrometric chart represents the properties of a sample of air at a particular temperature and moisture level. At point A, for example, the air sample has a temperature of 80°F (27°C), an RH of 40 percent, and an actual moisture content of about 0.009 lb of water per pound of dry air (12 g of water per kg of dry air).

PSYCHOMETRIC CHARTS
Temperature, Moisture

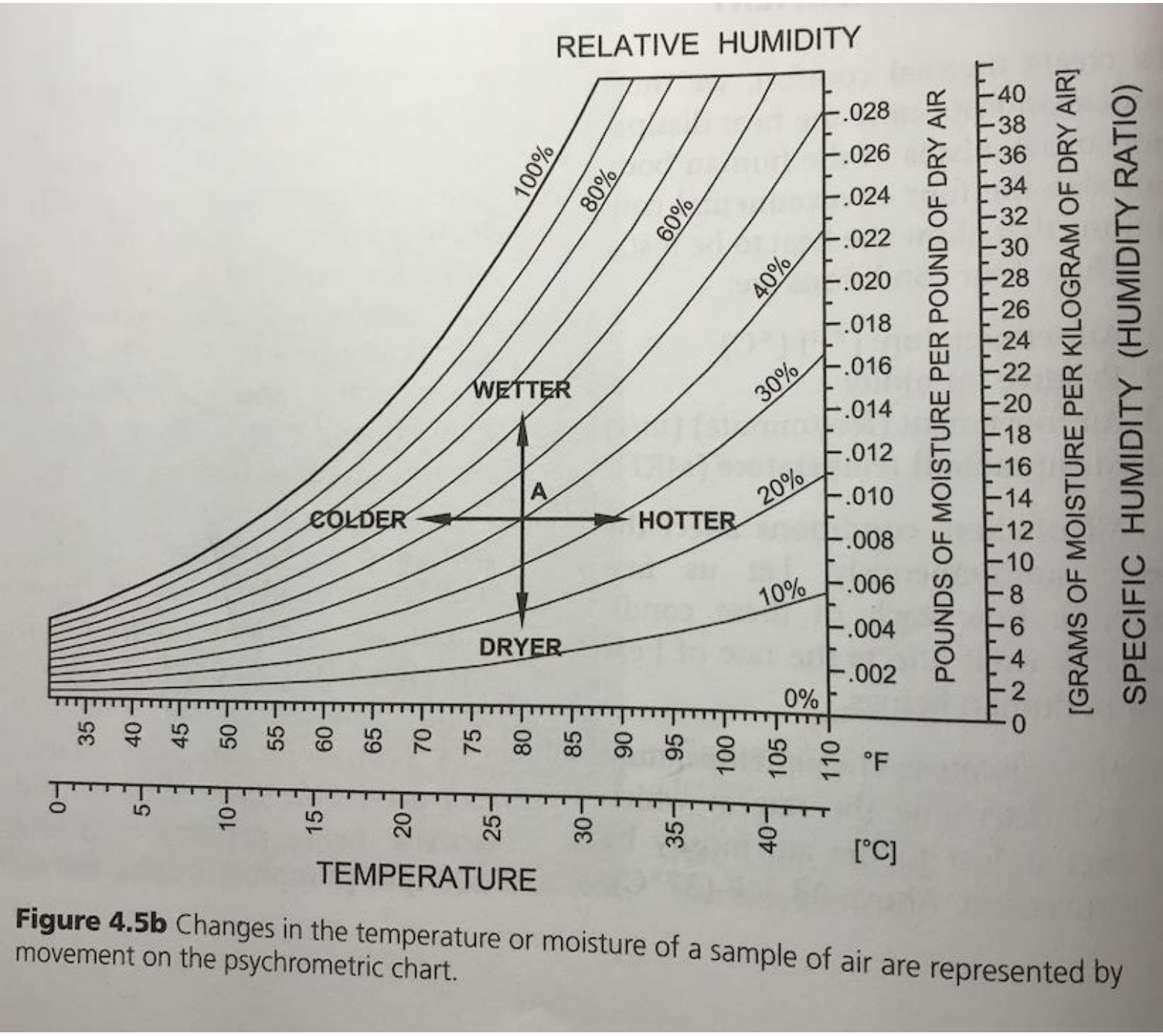


Figure 4.5b Changes in the temperature or moisture of a sample of air are represented by movement on the psychrometric chart.

PSYCHOMETRIC CHARTS
DESIGN: Heating lowers RH
w/ no Moisture content change

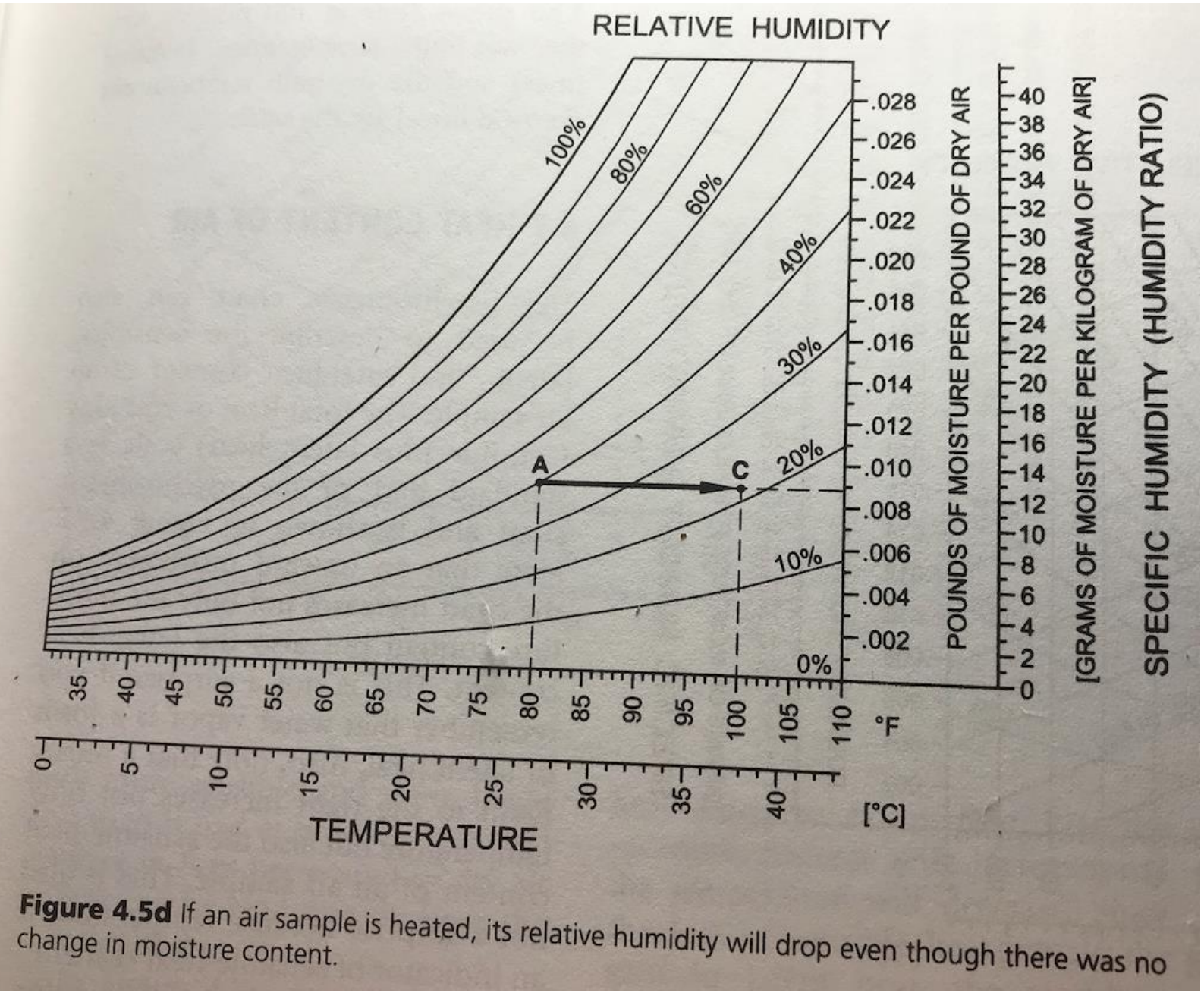


Figure 4.5d If an air sample is heated, its relative humidity will drop even though there was no change in moisture content.

PSYCHOMETRIC CHARTS
DESIGN: Cooling raises RH
w/ no Moisture content change

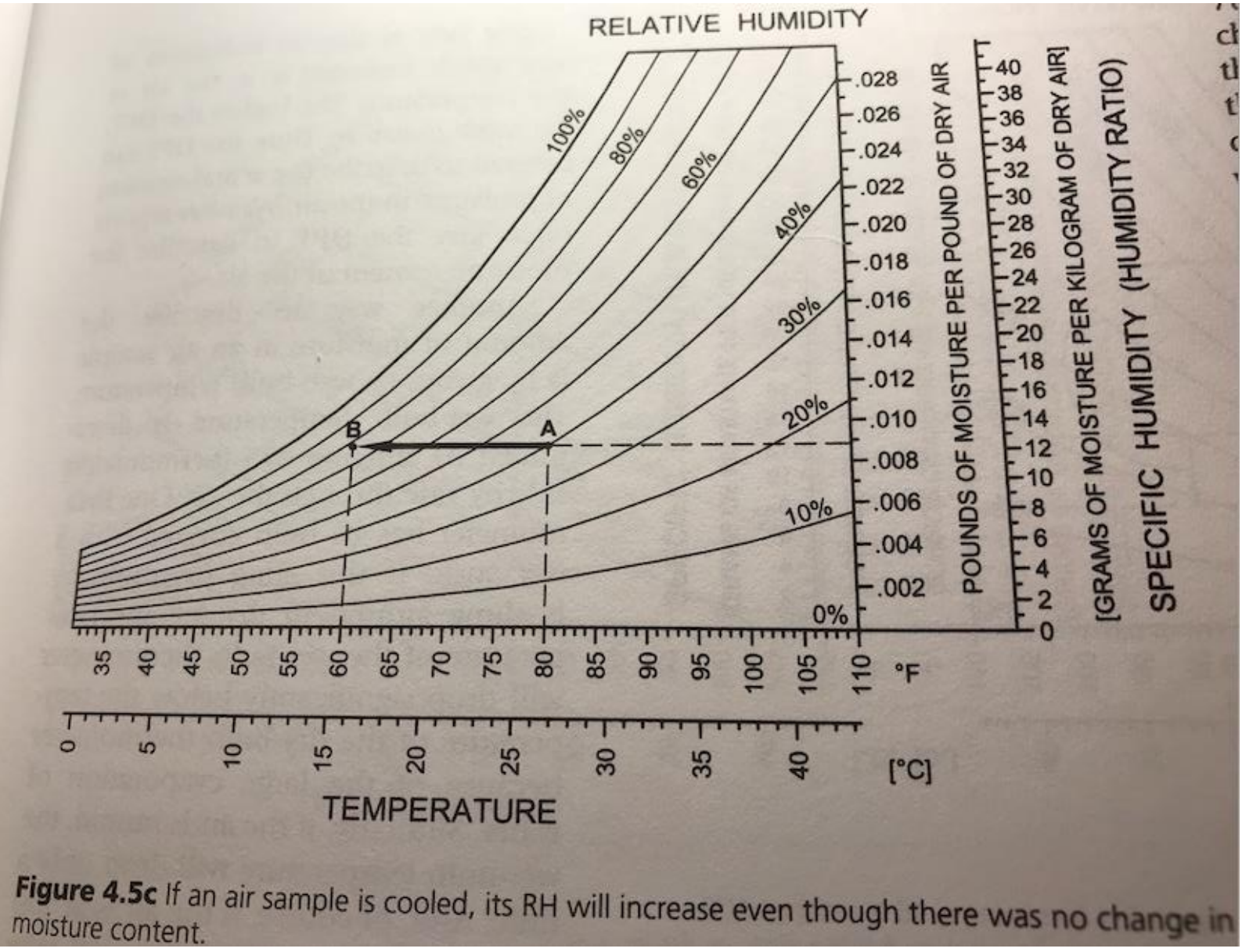
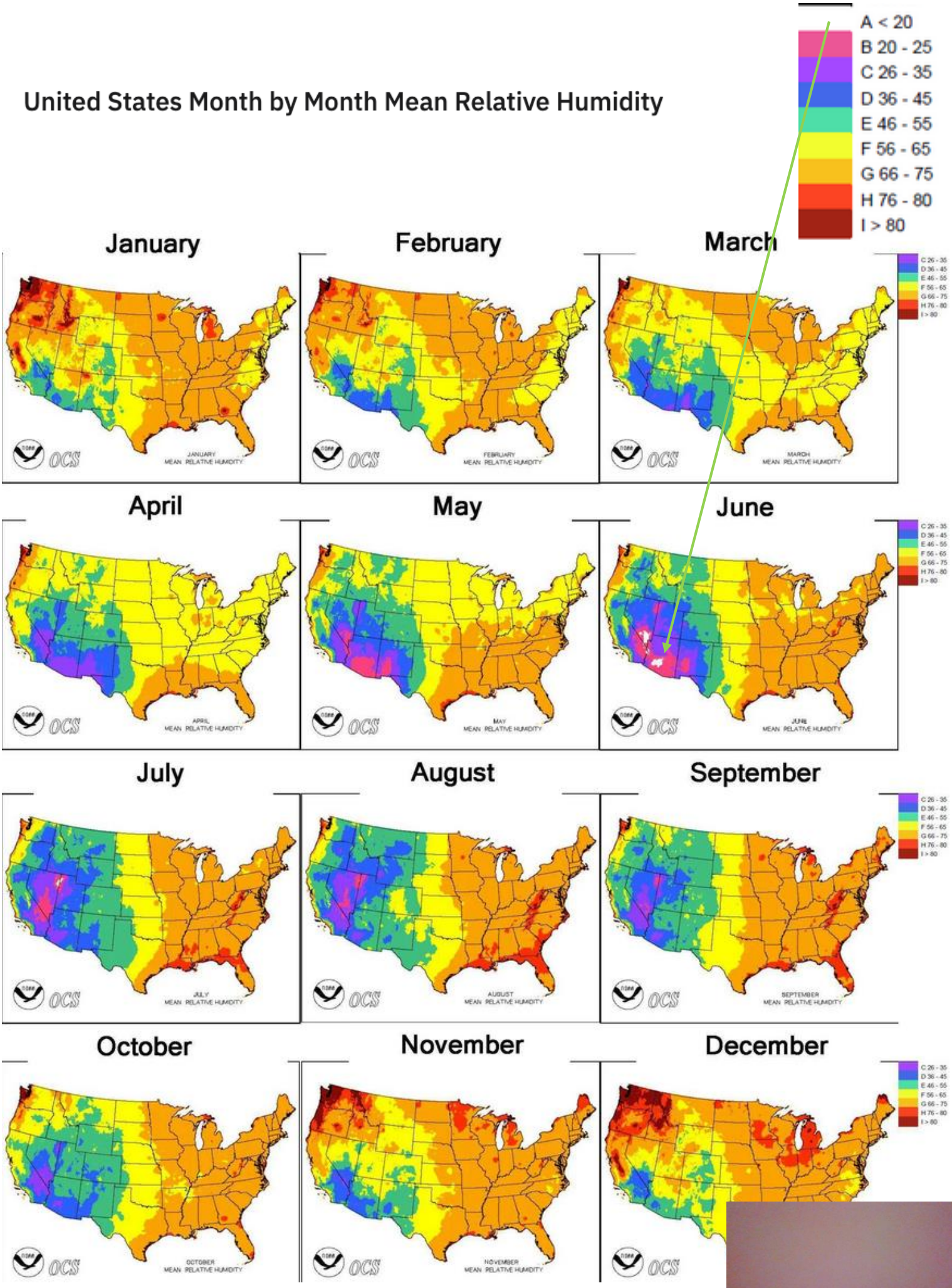


Figure 4.5c If an air sample is cooled, its RH will increase even though there was no change in moisture content.

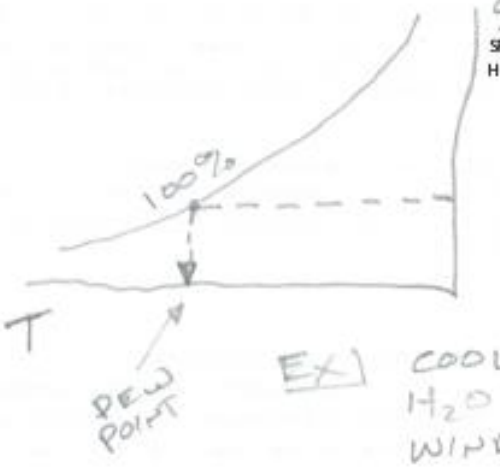
United States Month by Month Mean Relative Humidity



JT Wunderlich PhD

https://www.reddit.com/r/MapPorn/comments/143yas/united

"DEW POINT"
TEMP AT RH = 100% FOR A FIXED S.H.



i.e. THE TEMP AT WHICH WATER WILL CONDENSE OUT OF THE AIR

EX] COOL HOUSE UNTIL H_2O CONDENSES ON WINDOW INTERIORS

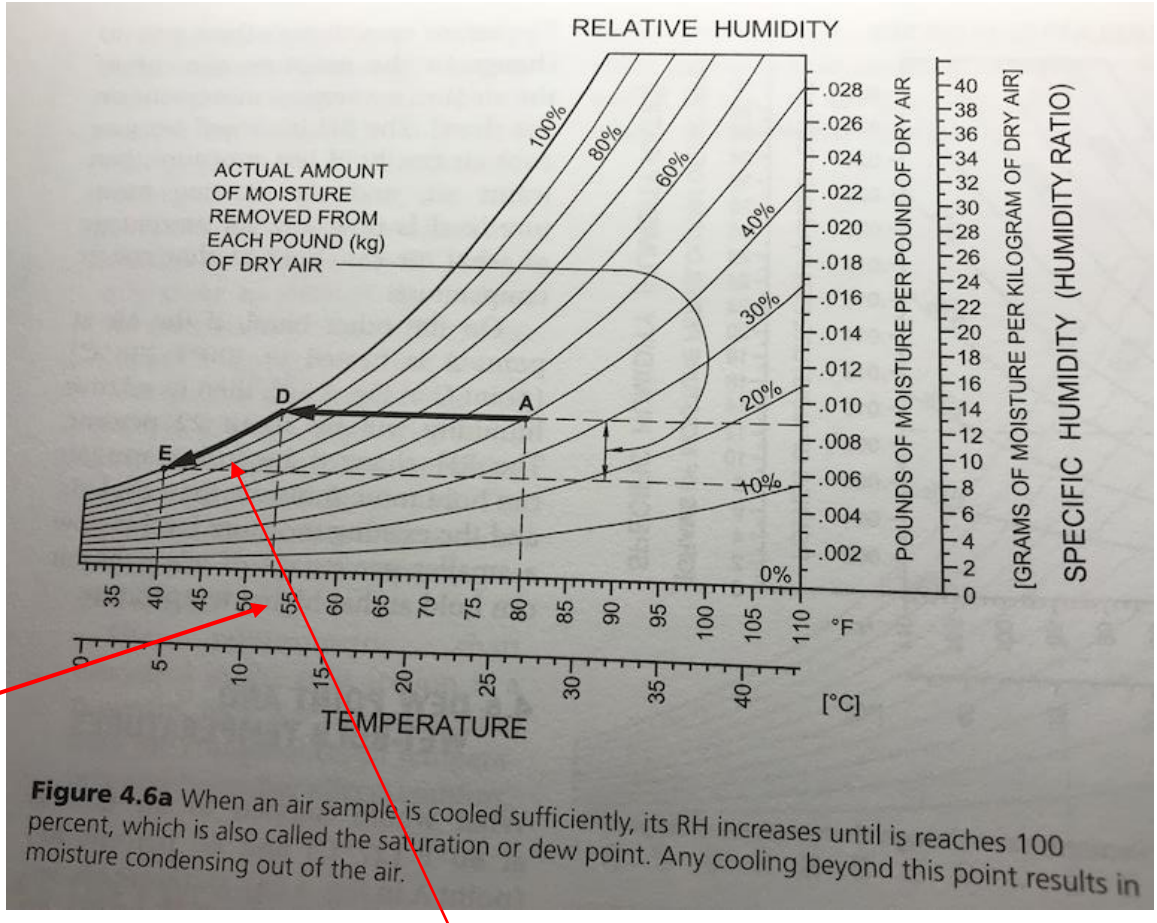
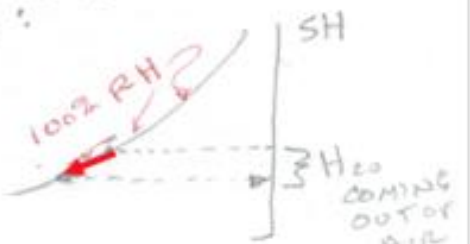


Figure 4.6a When an air sample is cooled sufficiently, its RH increases until is reaches 100 percent, which is also called the saturation or dew point. Any cooling beyond this point results in moisture condensing out of the air.

DEW POINT
At 53 degrees Fahrenheit

EX] COOL HOUSE UNTIL H_2O CONDENSES ON WINDOW INTERIORS

"DEHUMIDIFIER" IF $\Delta T \downarrow$ PAST DEW POINT H_2O COMES OUT OF AIR:

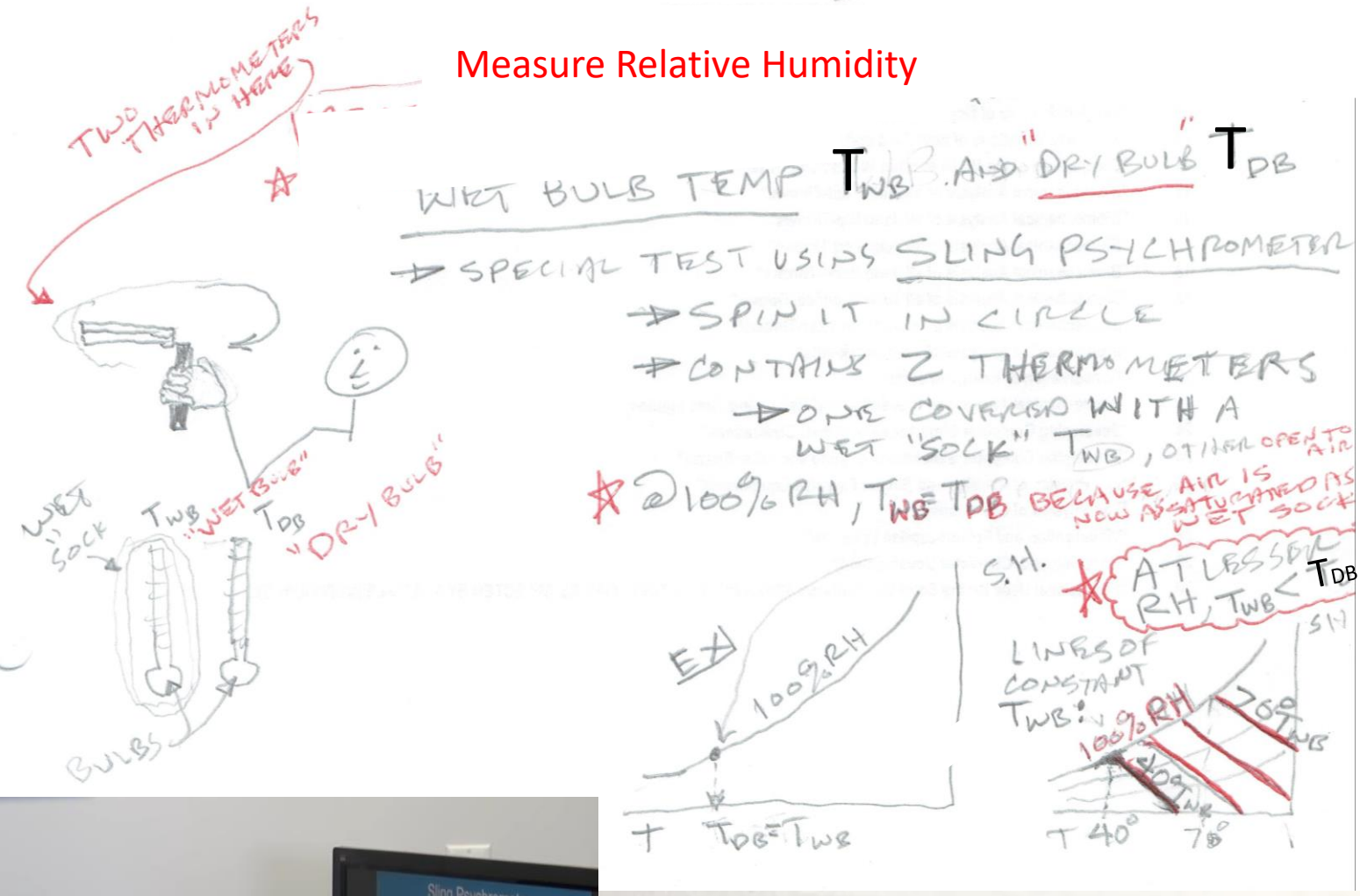


JT Wunderlich PhD

WET BULB and DRY BULB Temperature

WATCH: https://www.youtube.com/watch?v=rb5Zs5lYg9Y

Measure Relative Humidity



Modern electronic device for measuring **R**elative **H**umidity
https://www.youtube.com/watch?v=s7J6R9wECh8

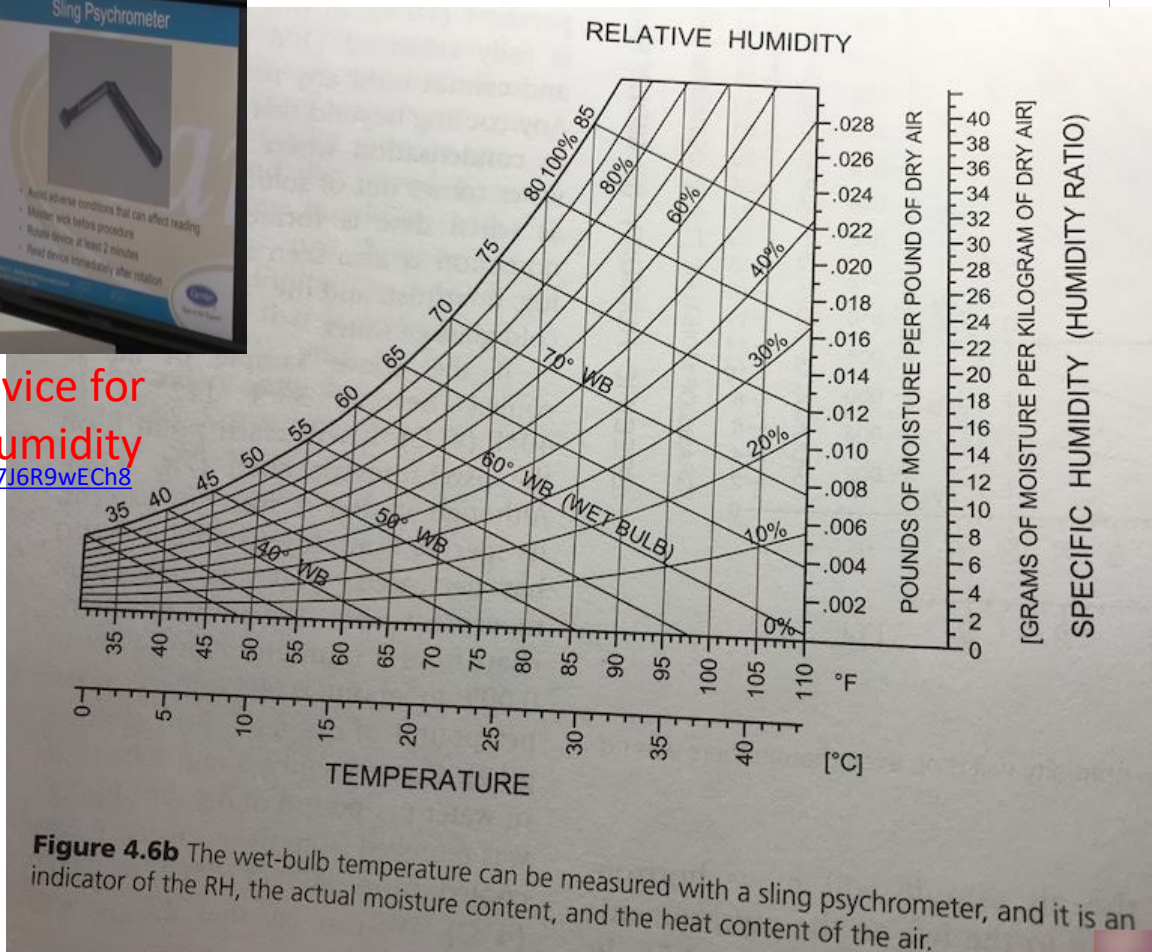


Figure 4.6b The wet-bulb temperature can be measured with a sling psychrometer, and it is an indicator of the RH, the actual moisture content, and the heat content of the air.

JT Wunderlich PhD

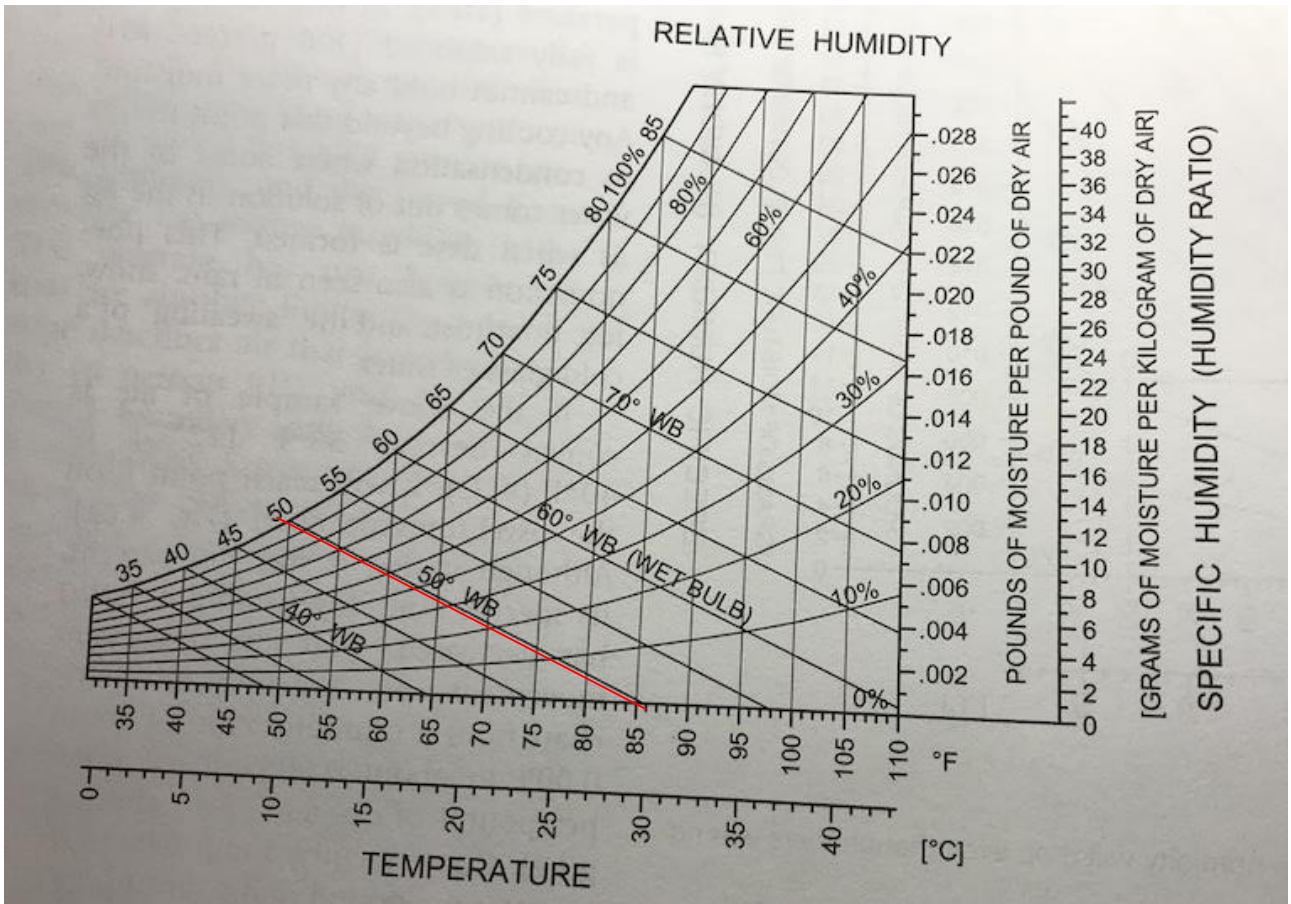
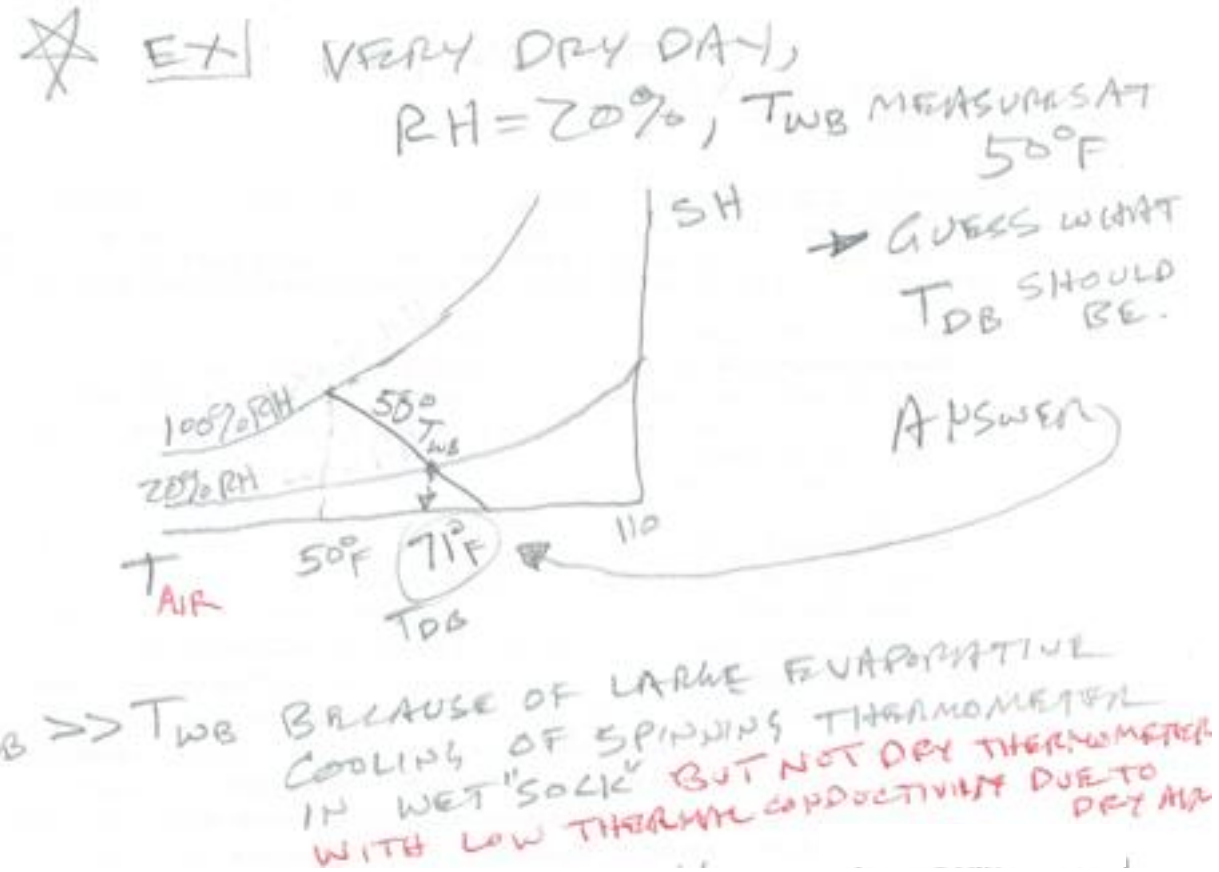
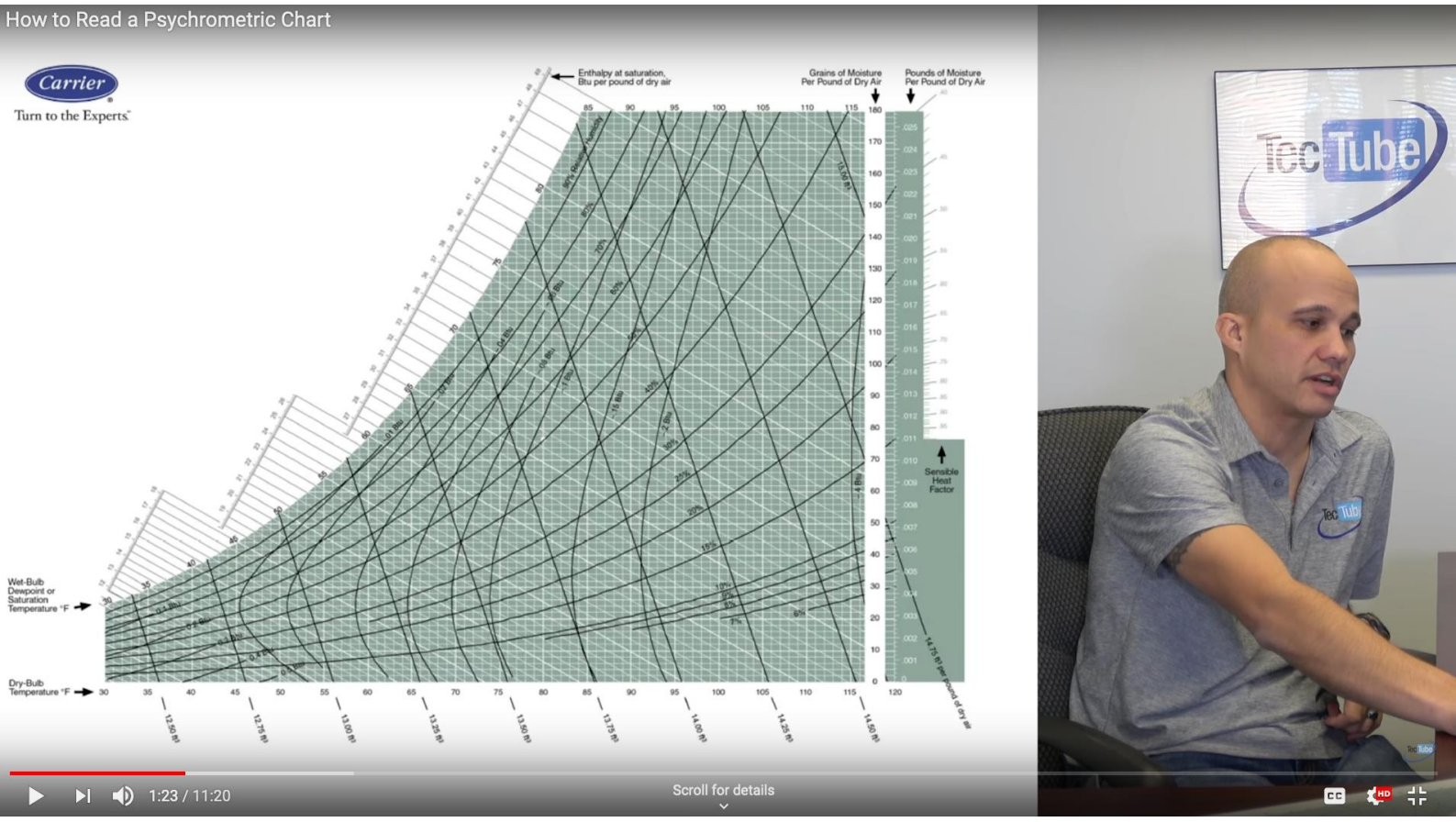
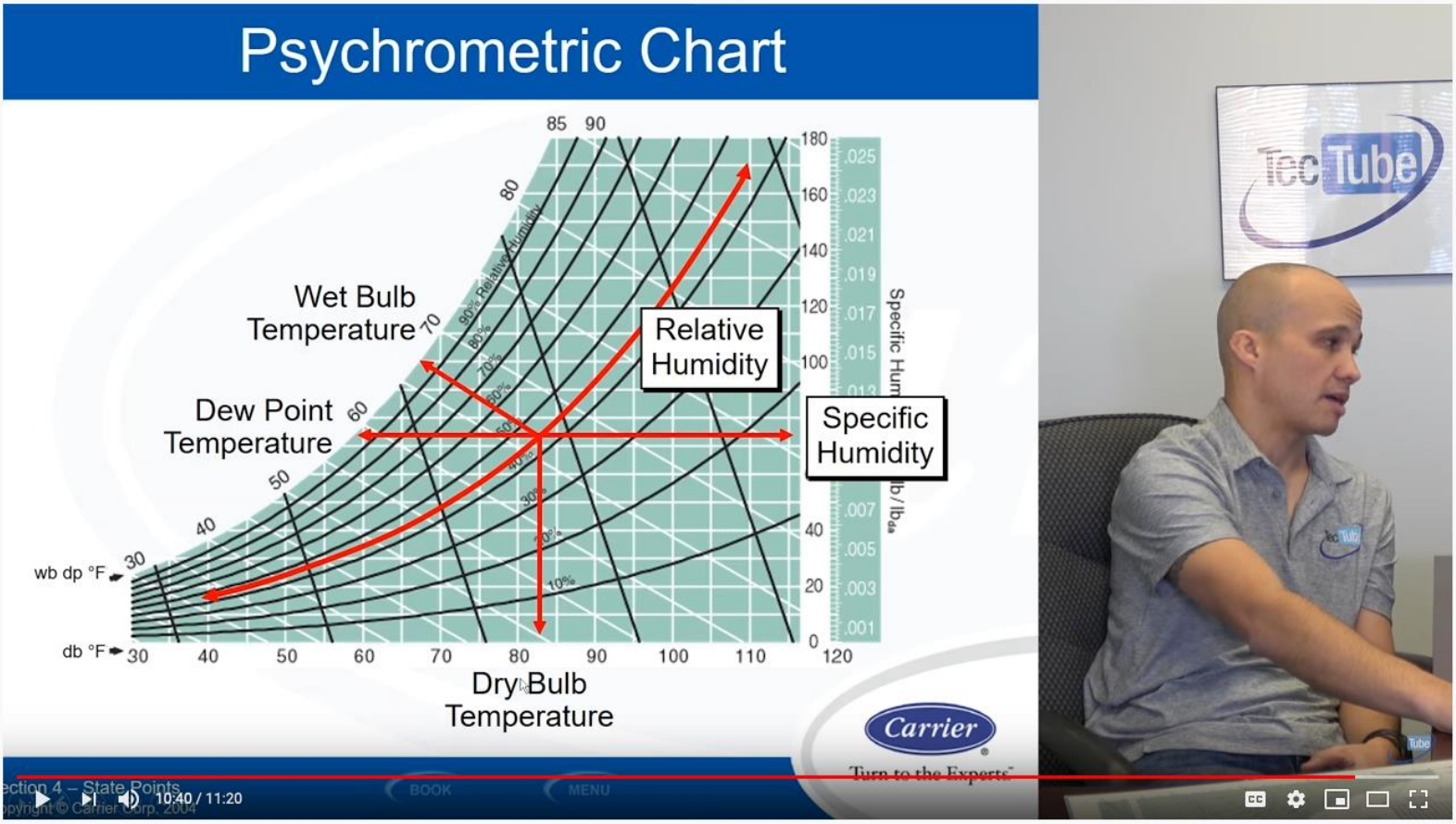


Figure 4.6b The wet-bulb temperature can be measured with a sling psychrometer, and it is an indicator of the RH, the actual moisture content, and the heat content of the air.



WATCH (outside of class time):
https://www.youtube.com/watch?v=s7J6R9wECh8





NORTH AURORA
How to Read a Psychrometric Chart
115,071 views • Mar 21, 2018
1.5K 28 SHARE SAVE

JT Wunderlich PhD

ENTHALPY

"HEAT CONTENT OF AIR"

"TOTAL HEAT (ENTHALPY)"

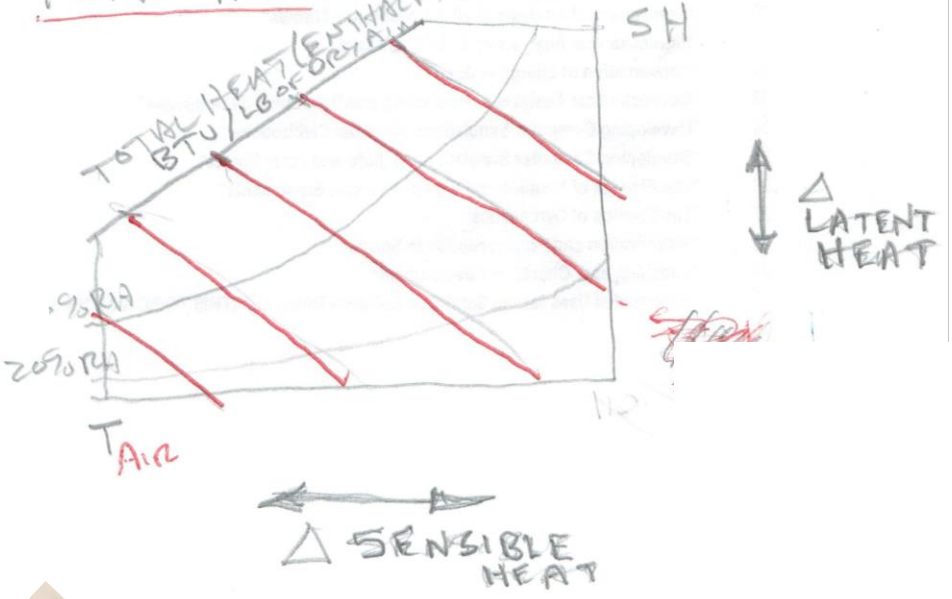
= SENSIBLE HEAT + LATENT HEAT

RECALL "HEAT STORED" $= \sum (\Delta T)_{AIR}$

RECALL "HEAT NEEDED TO Δ STATE" $= \sum (\Delta H_2O)$

∴ MOISTURE IN AIR

SO PLOT LINES OF CONSTANT TOTAL HEAT



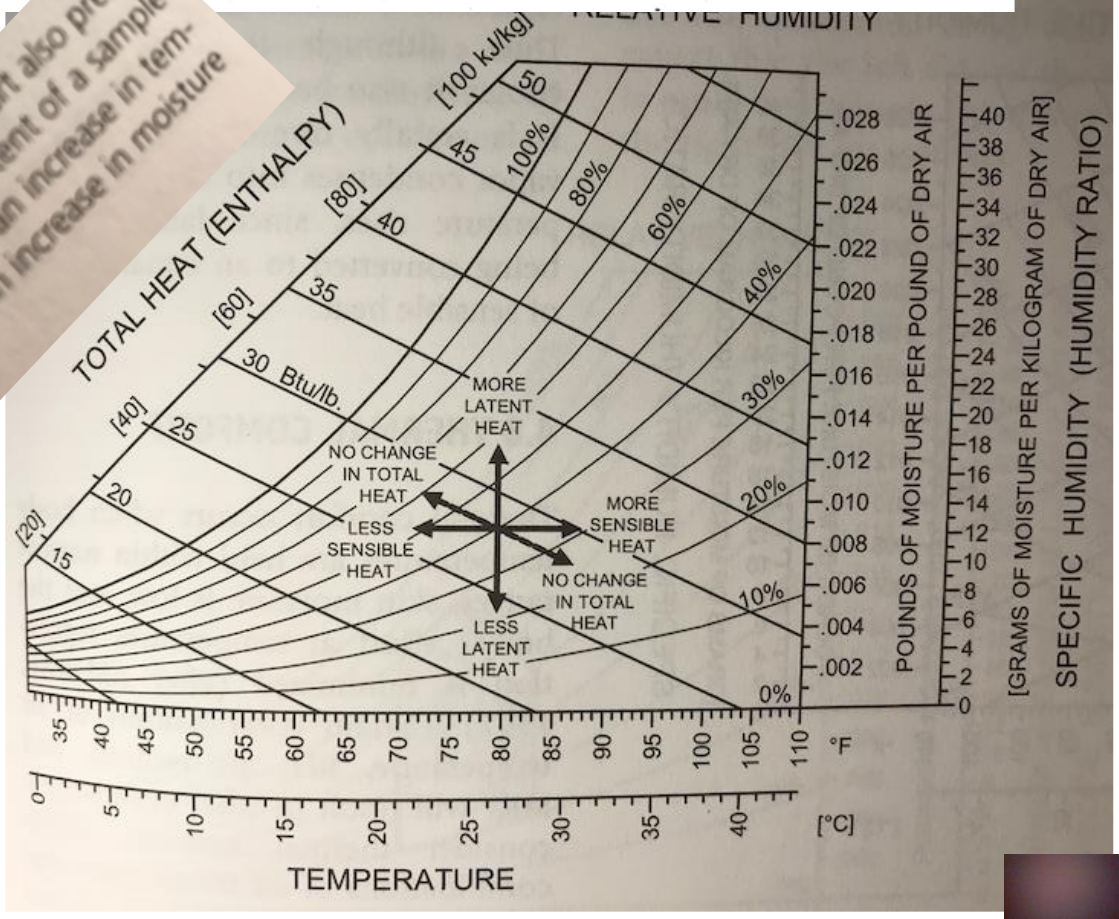


Figure 4.7a The psychrometric chart also presents information on the heat content of a sample of air. Heat is gained by either an increase in temperature (sensible heat) or an increase in moisture (latent heat) or both.

JT Wunderlich PhD

DESIGN: Heat and Humidify Air

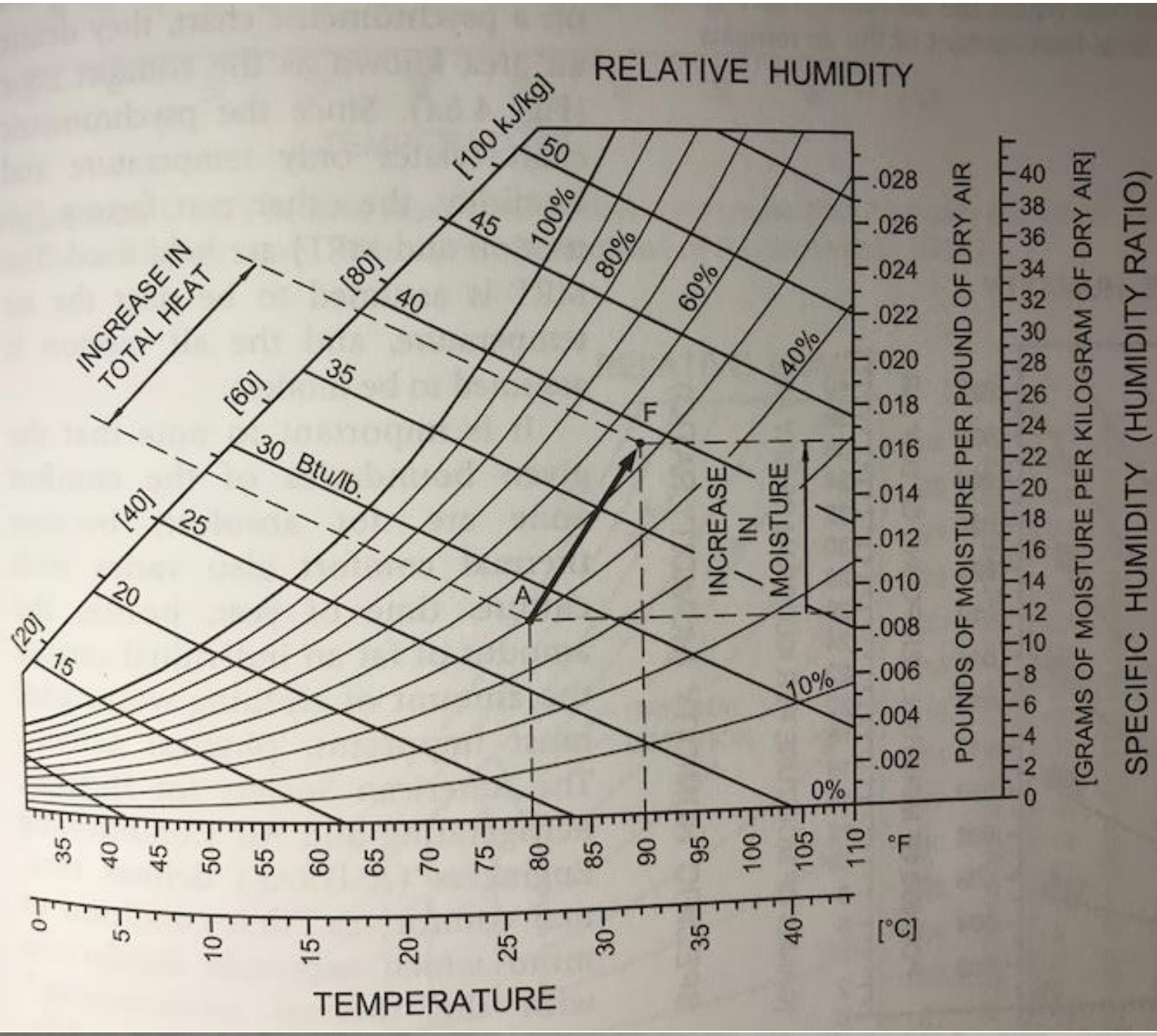


Figure 4.7b Heating and humidifying an air sample increases both its sensible and latent heat. The total-heat gain can be read directly from the enthalpy scale.

DESIGN: Evaporative Cooling

Is **adiabatic** [ad-ee-uh-bat-ik,

i.e., No Enthalpy Change

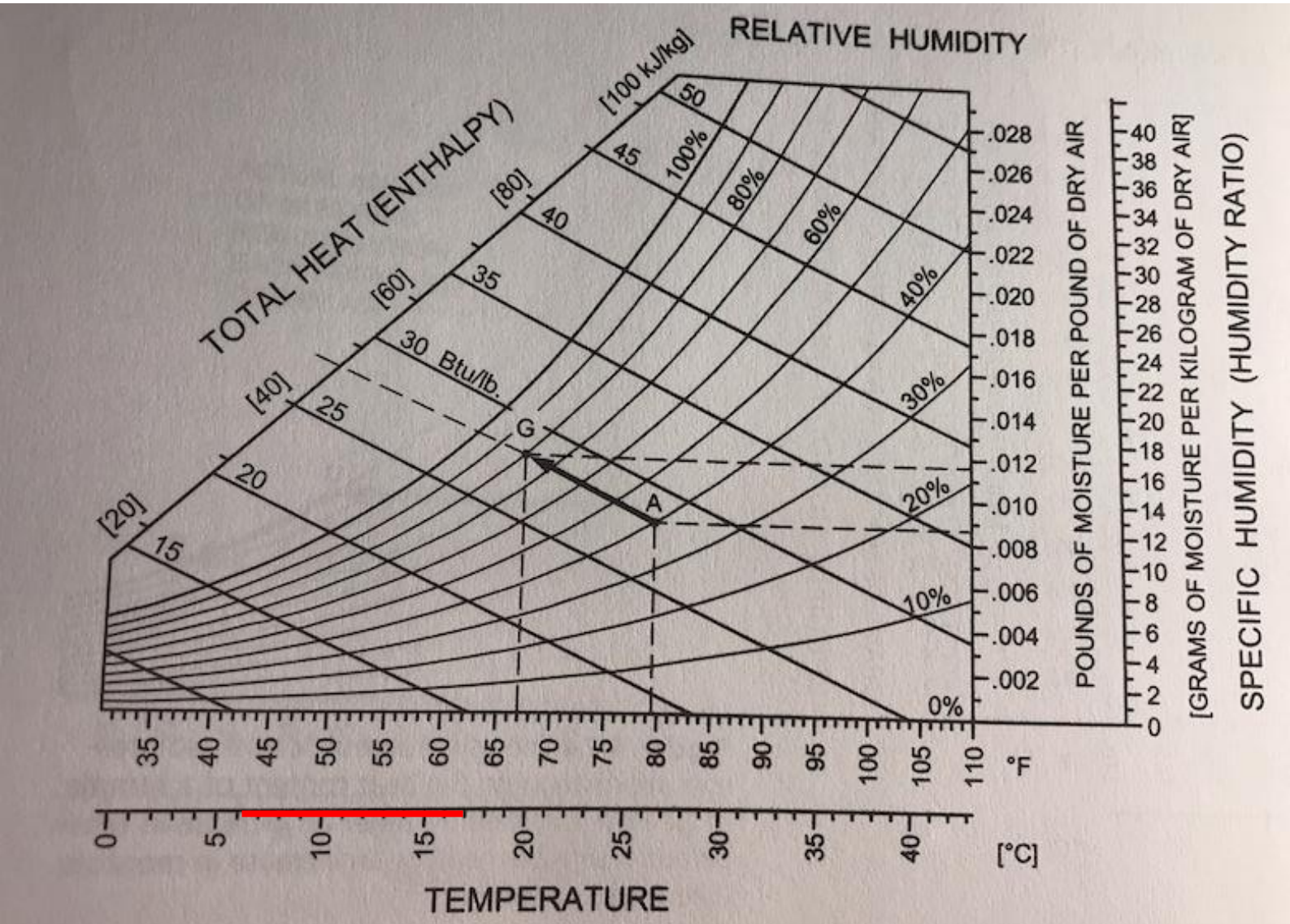


Figure 4.7c In evaporative cooling, the increase in latent heat equals the decrease in sensible heat. An adiabatic change is a change in which the total-heat content of the air remains

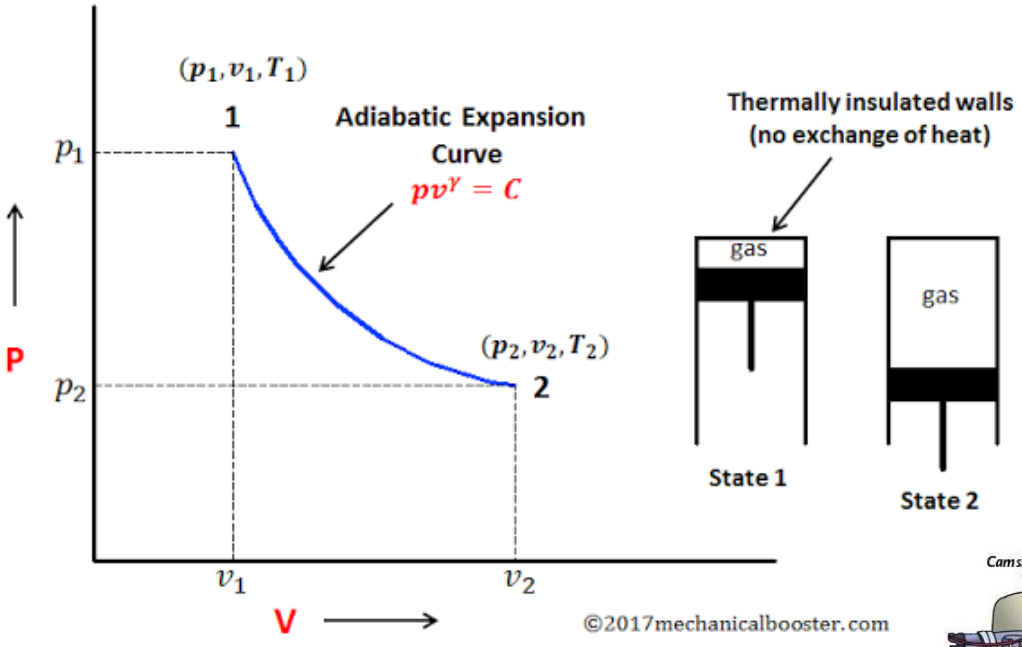
https://www.dictionary.com/browse/adiabatic?s=t

adiabatic [ad-ee-*uh*-**bat**-ik, ey-dahy-*uh*-] SHOW IPA

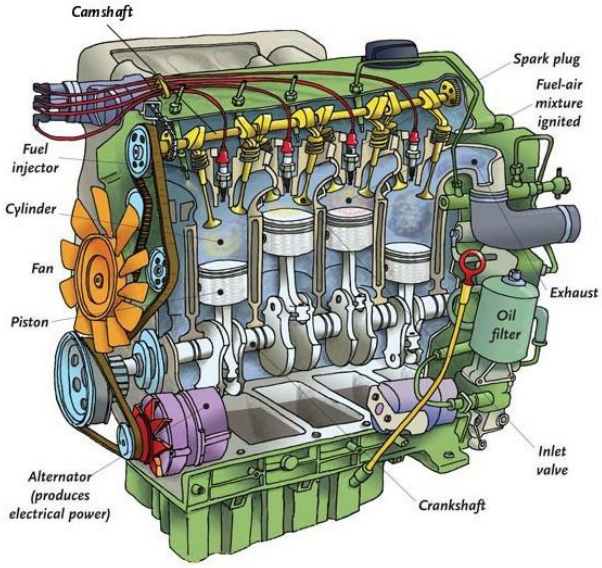
adjective

1 occurring without gain or loss of heat (opposed to diabatic):
an adiabatic process.

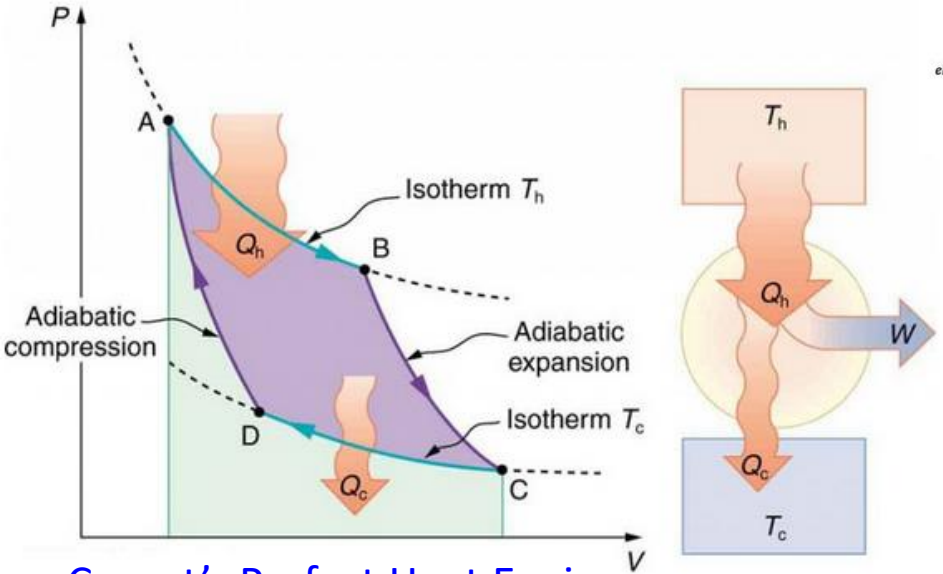
https://www.mechanicalbooster.com/2017/10/what-is-adiabatic-process.html



Adiabatic Process



https://www.q-files.com/technology/road-transport/internal-combustion-engine

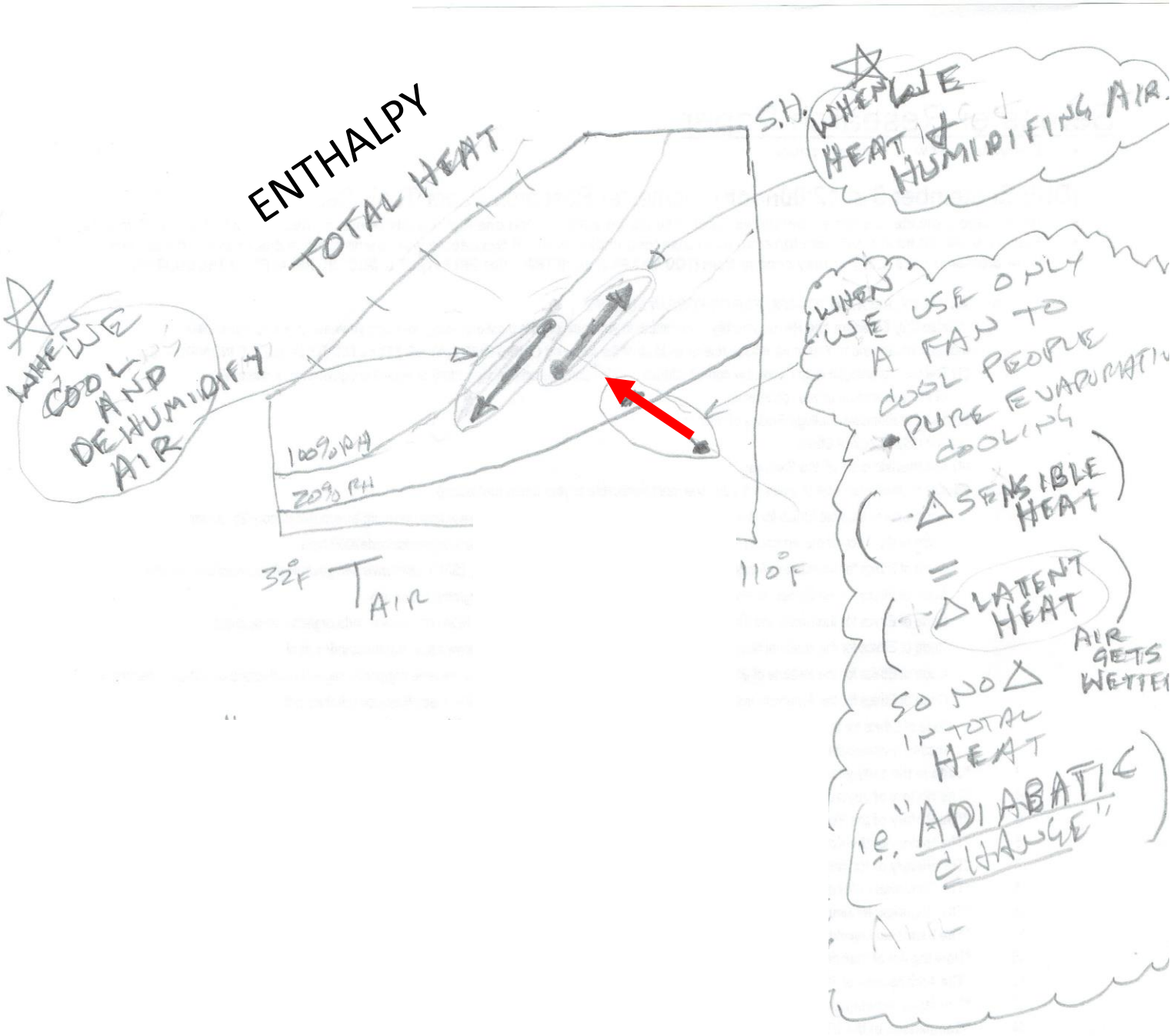


Carnot's Perfect Heat Engine

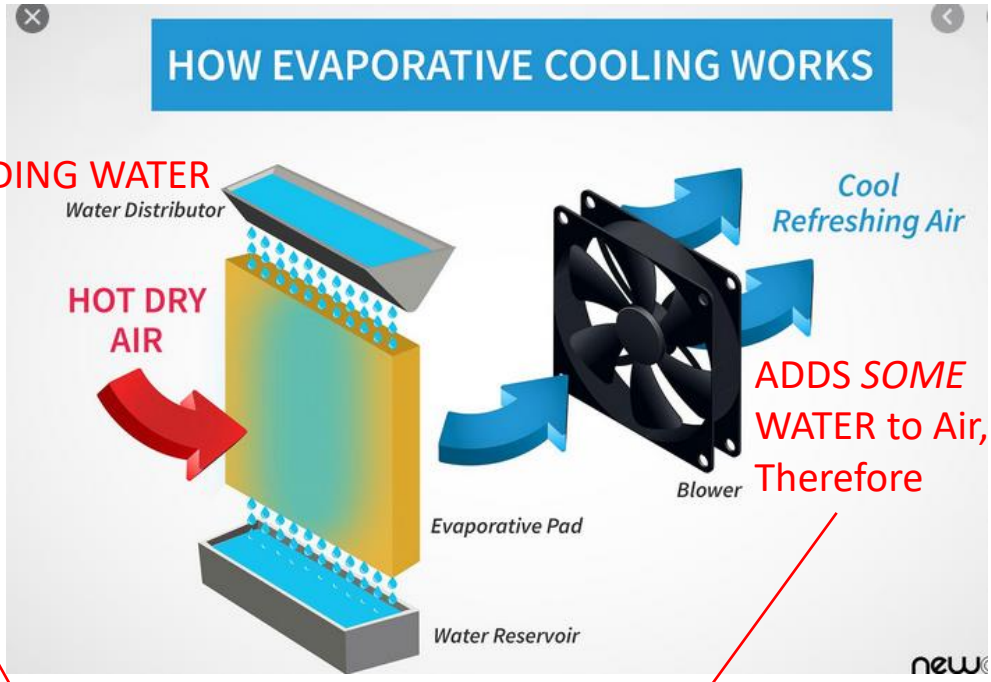
"WORK" e.g., the Mechanical "Work" of a combustion engine

adiabatic

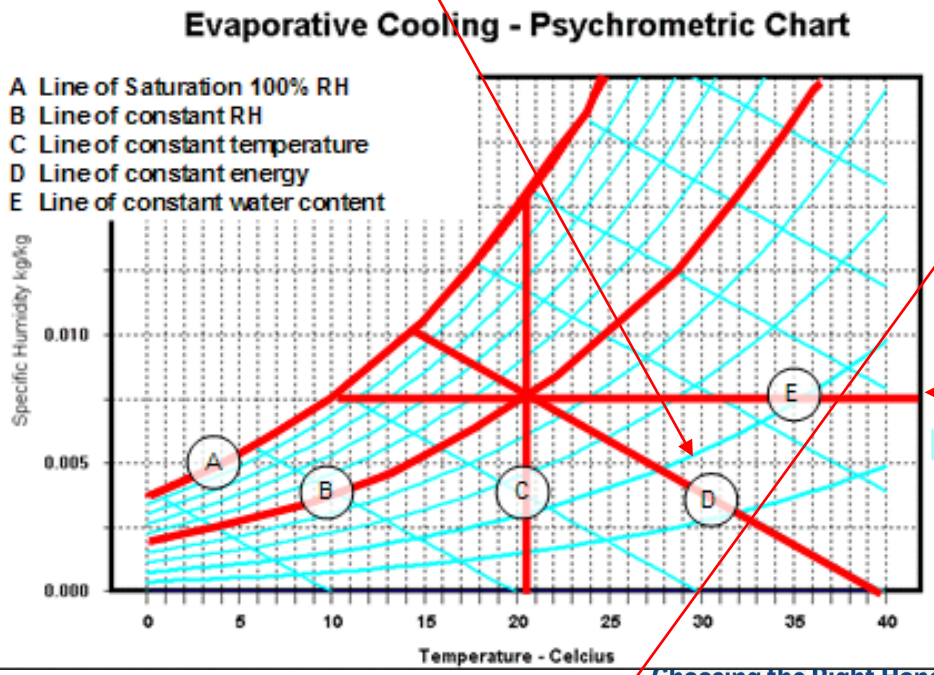
Adiabatic COOLING of PEOPLE Using only a FAN



EVAPORATIVE COOLERS (Adiabatic)

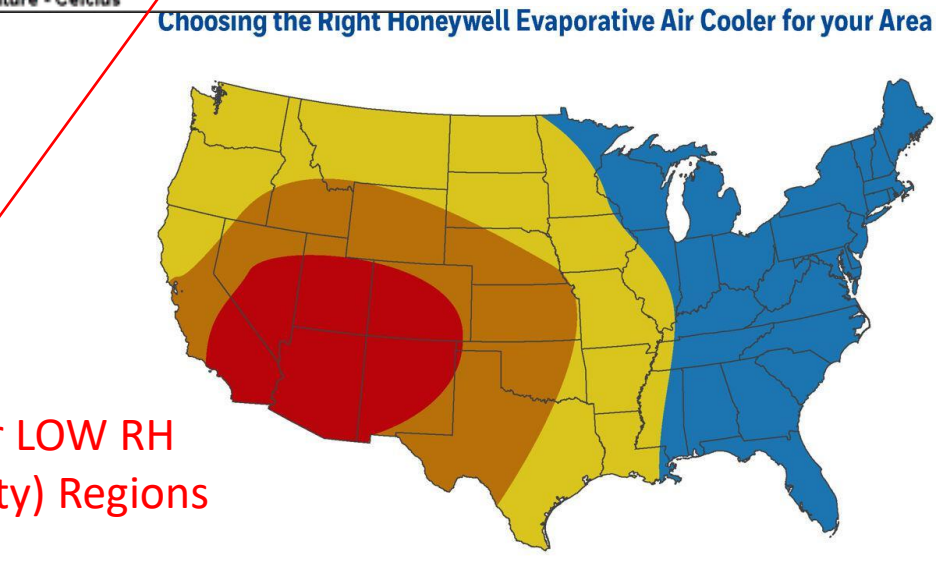


https://theozonehole.com/the-best-portable-swamp-coolers-for-home.htm



https://www.pinterest.com/pin/192388215306794802/

NOTE: This is the line of Constant Water Content

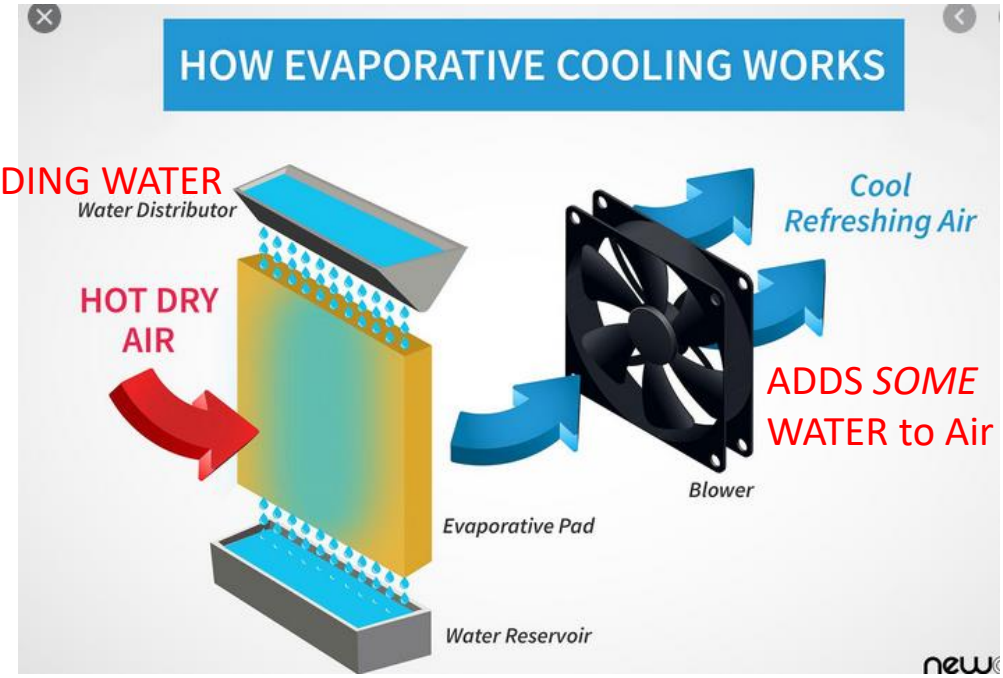


Most suitable for LOW RH (Relative Humidity) Regions

https://www.homedepot.com/p/Honeywell-194-CFM-3-Speed-Portable-Evaporative-Cooler-for-120-sq-ft-with-Remote-Control-in-White-TC10PEU/310163101

EVAPORATIVE COOLERS (Adiabatic)

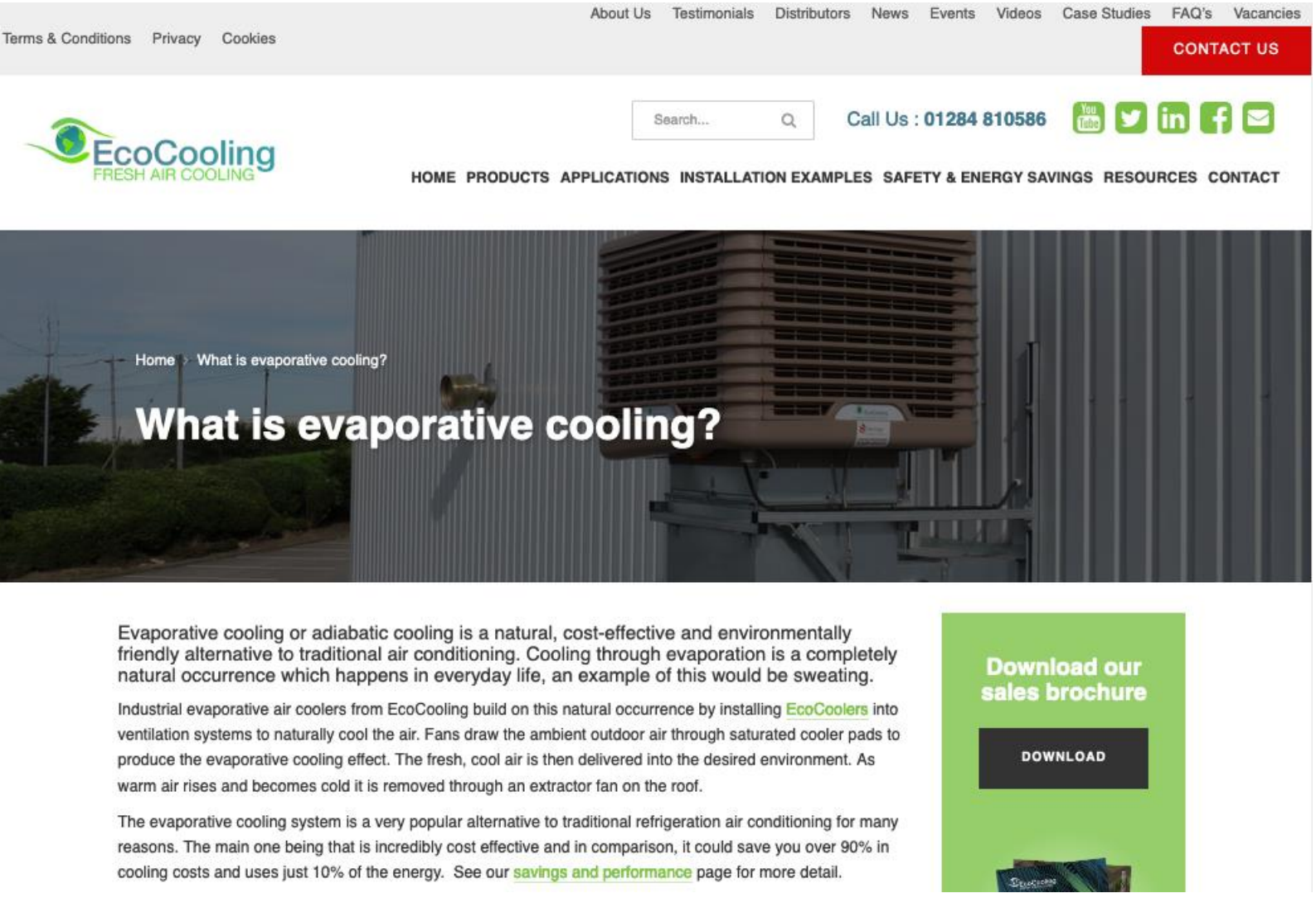
ADDING WATER



https://theozonehole.com/the-best-portable-swamp-coolers-for-home.htm

Adiabatic COOLING of PEOPLE Using only a FAN and WATER VAPOR

https://www.ecocooling.co.uk/what-is-evaporative-cooling/

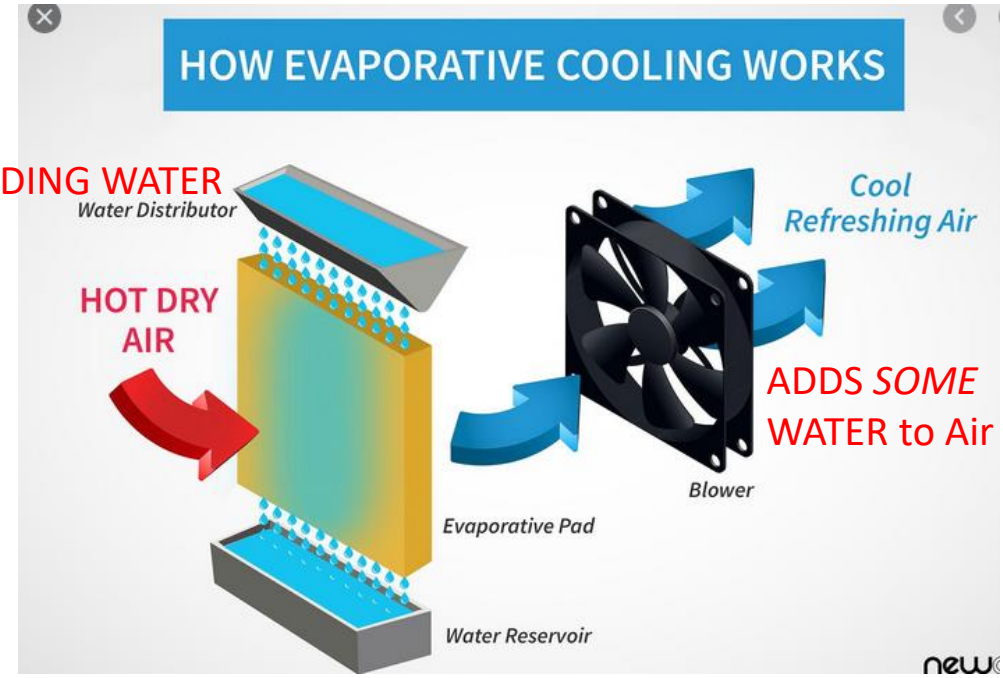


Evaporative cooling or adiabatic cooling is a natural, cost-effective and environmentally friendly alternative to traditional air conditioning. Cooling through evaporation is a completely natural occurrence which happens in everyday life, an example of this would be sweating.

Industrial evaporative air coolers from EcoCooling build on this natural occurrence by installing EcoCoolers into ventilation systems to naturally cool the air. Fans draw the ambient outdoor air through saturated cooler pads to produce the evaporative cooling effect. The fresh, cool air is then delivered into the desired environment. As warm air rises and becomes cold it is removed through an extractor fan on the roof.

The evaporative cooling system is a very popular alternative to traditional refrigeration air conditioning for many reasons. The main one being that is incredibly cost effective and in comparison, it could save you over 90% in cooling costs and uses just 10% of the energy. See our savings and performance page for more detail.

EVAPORATIVE COOLERS (Adiabatic)



https://theozonehole.com/the-best-portable-swamp-coolers-for-home.htm

Advantages of Using Direct Evaporative Cooling

- No refrigerants, completely natural cooling process which uses only fresh air.
- Low running and maintenance costs
- Low carbon and energy use
- Exploits the maximum amount of free cooling available
- Low energy use even at partial population
- No use of recycled air

GOOD FOR COVID

WATCH: https://www.youtube.com/user/ecocooling

COMPUTER DATA CENTER

JT Wunderlich PhD

The "Comfort Zone"

And Discomfort outside that zone

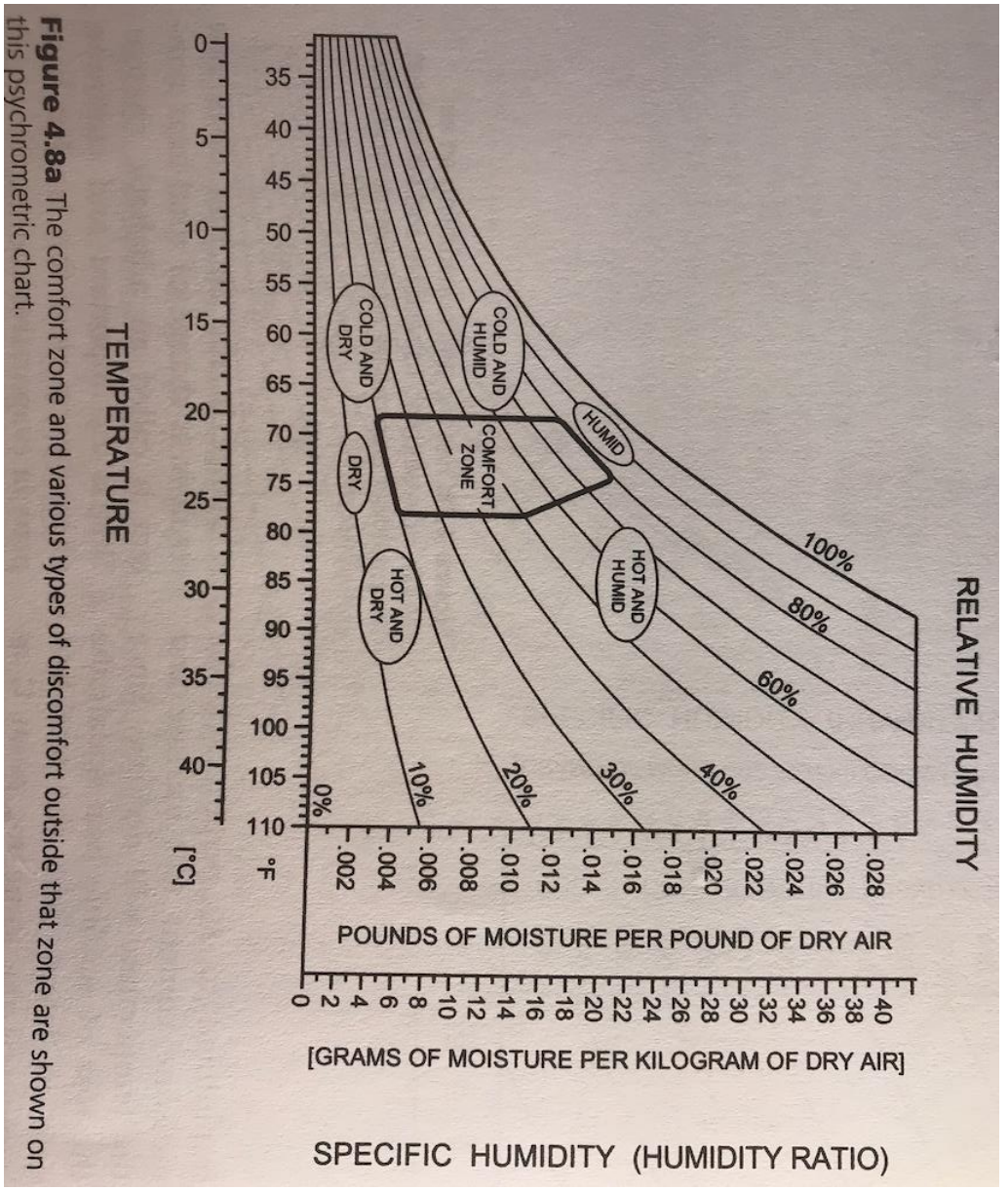


Figure 4.8a The comfort zone and various types of discomfort outside that zone are shown on this psychrometric chart.

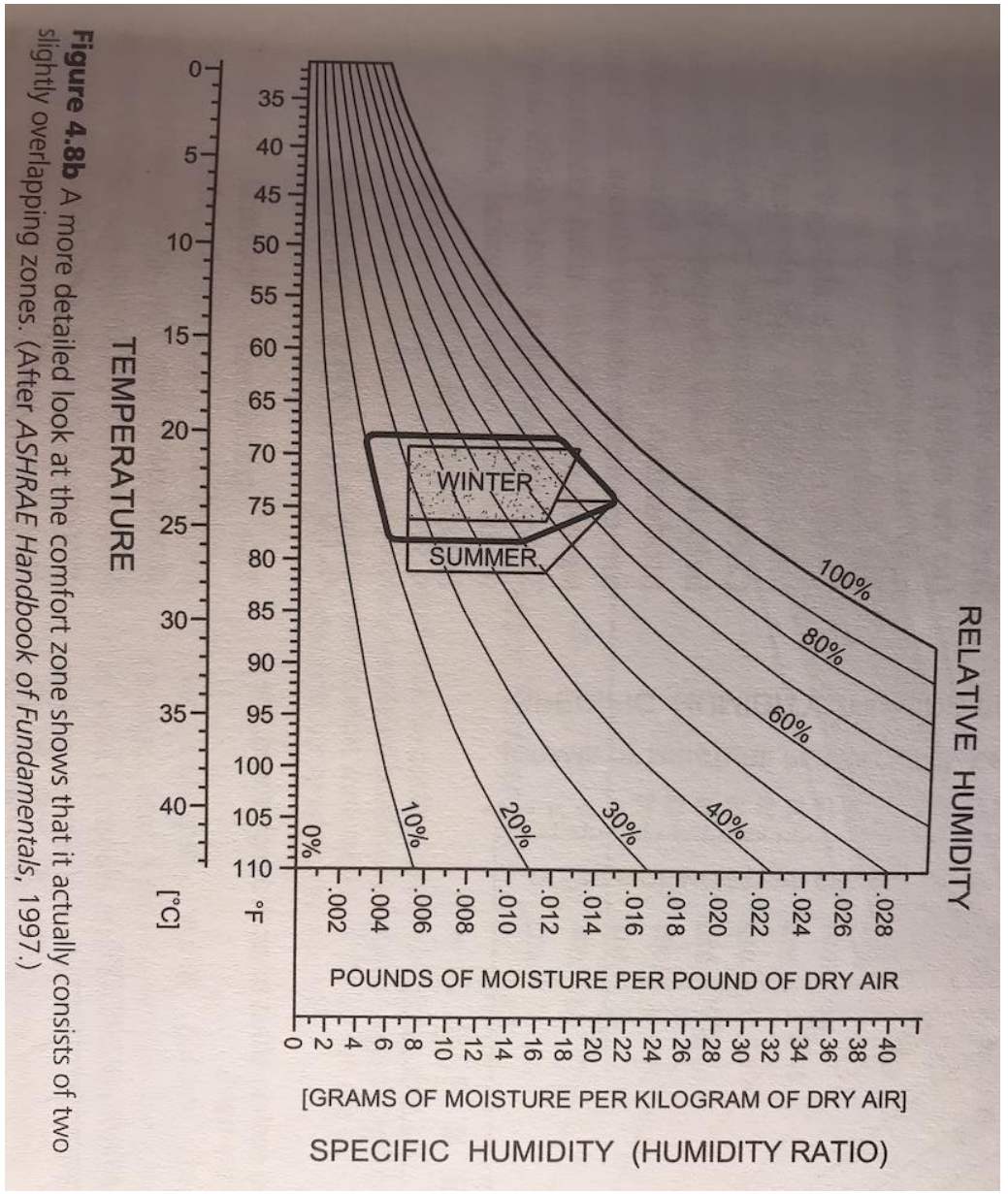
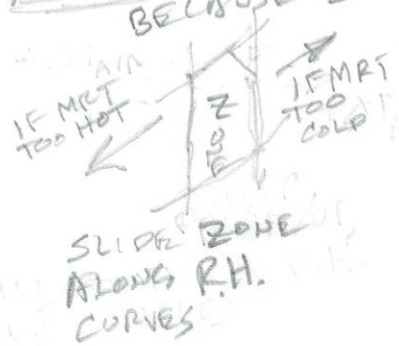


Figure 4.8b A more detailed look at the comfort zone shows that it actually consists of two slightly overlapping zones. (After *ASHRAE Handbook of Fundamentals*, 1997.)

"SHIFTING OF COMFORT ZONE"

NOW ADRESS ASSUMPTIONS IN DESIGN RULES!

★ (A) FOR EVERY M.R.T. ± 3°F ⇒ ADJUST AIR TEMP IN OPPOSITE DIRECTION BECAUSE ZONE SHIFTS



I.E., COMPENSATING FOR OVERLY INTENSE SOURCES OF HOT OR COLD, LIKE:

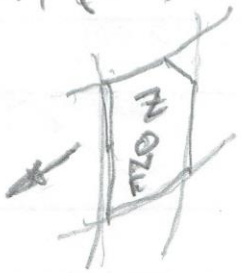
- → BIG WINDOWS
- → FIRE PLACES

★★ CAN MITIGATE WITH
- → THERMAL DRAPES ON WINDOWS
- → GLASS SCREEN ON FIRE PLACE

★ (B) FOR EVERY AIR SPEED (feet per minute) + 15 fpm (FEET PER MINUTE), COMFORT DROPS 1°F

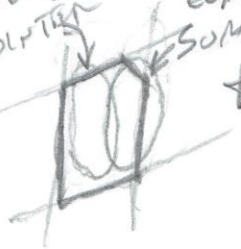
★★ SO ADJUST AIR TEMP UP 1°F

★ (C) FOR INCREASE IN PHYSICAL ACTIVITY (GYMS ETC.), ★★ MORE COMFORT IF T_{AIR} ↓



★ (D) SEASONAL VARIATIONS

COMFORT ZONE = $\int$ (SUMMER ZONE, WINTER ZONE)



★★ SO, GET VERY LOCATION SPECIFIC TO COMPENSATE ..... "BIOCLIMATIC CHARTS" CH.5

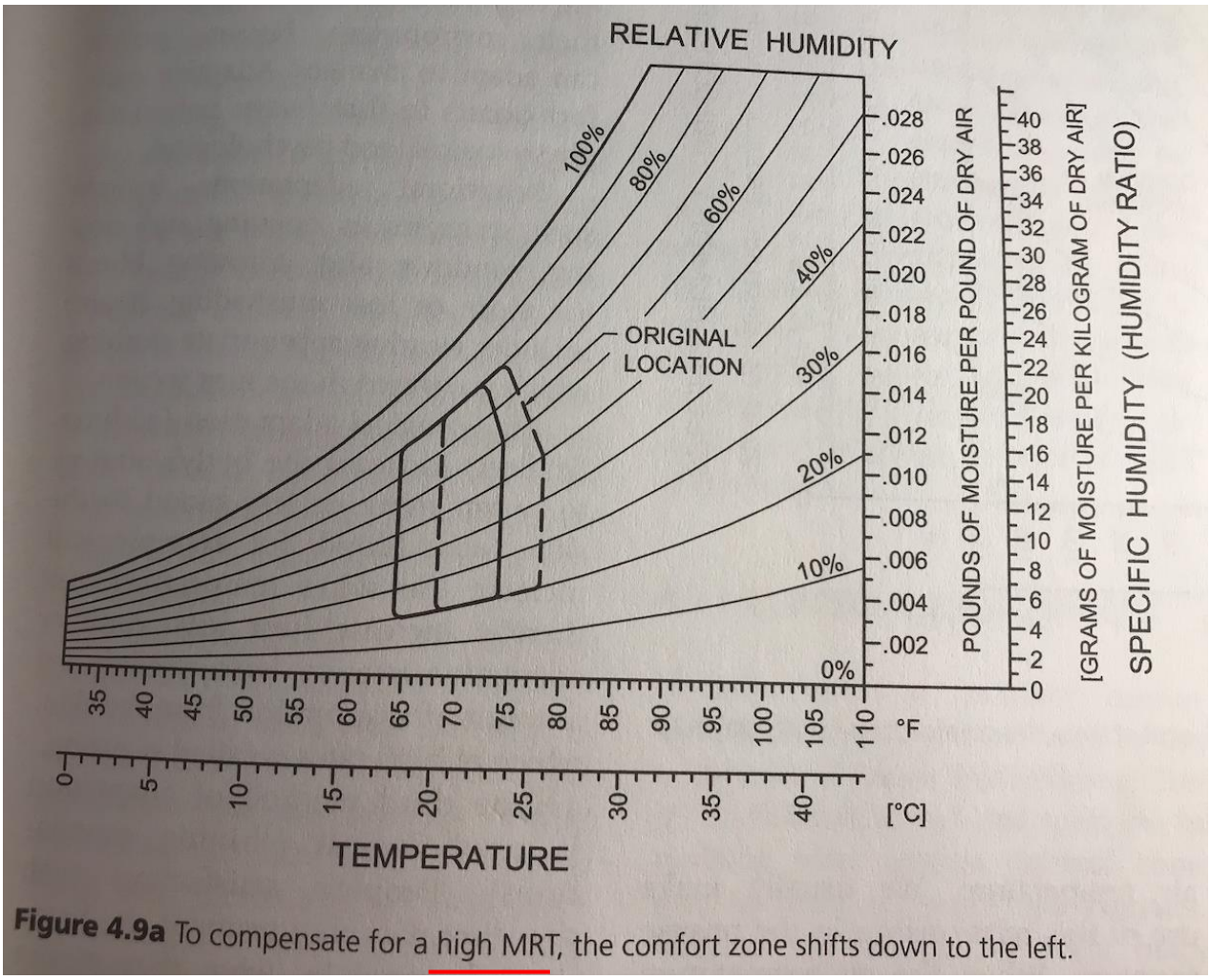


Figure 4.9a To compensate for a high MRT, the comfort zone shifts down to the left.

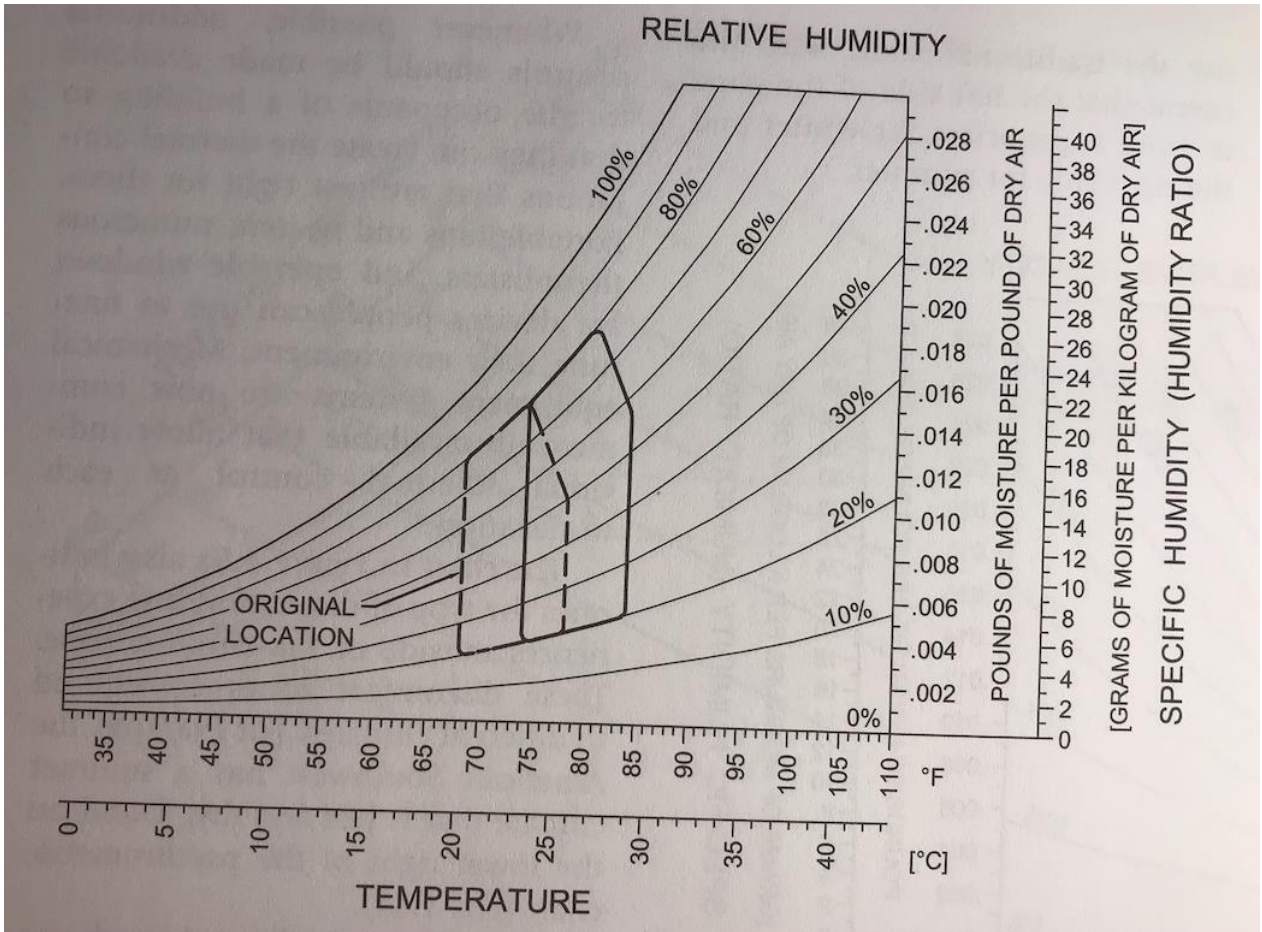


Figure 4.9b To compensate for high air velocity, the cooling effect of air at a high speed, the comfort zone shifts to warmer temperatures (i.e., to the right).

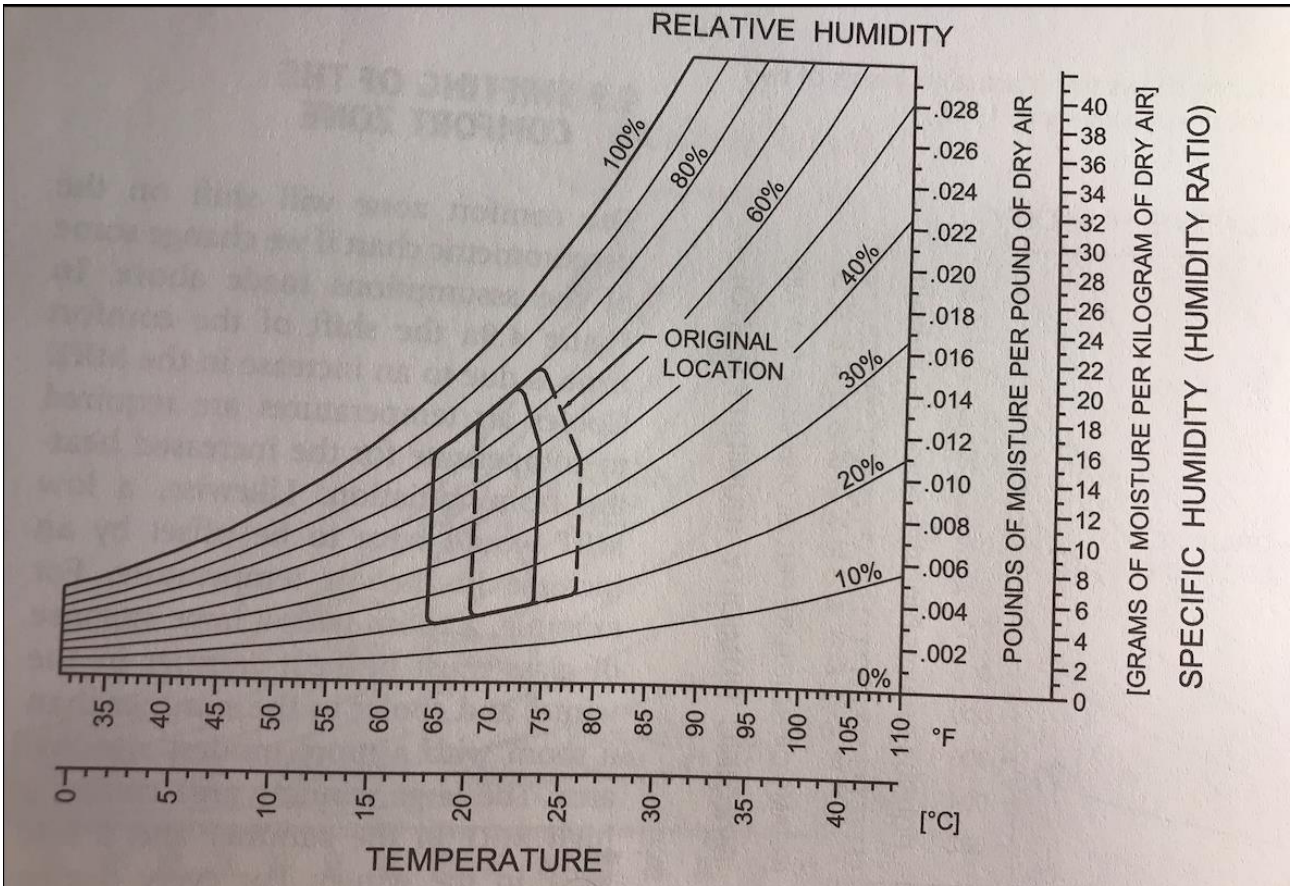


Figure 4.9c To compensate for an increase in physical activity, the comfort zone shifts down to cooler temperatures (i.e., to the left).

For PASSIVE HVAC
and to MITIGATE COVID

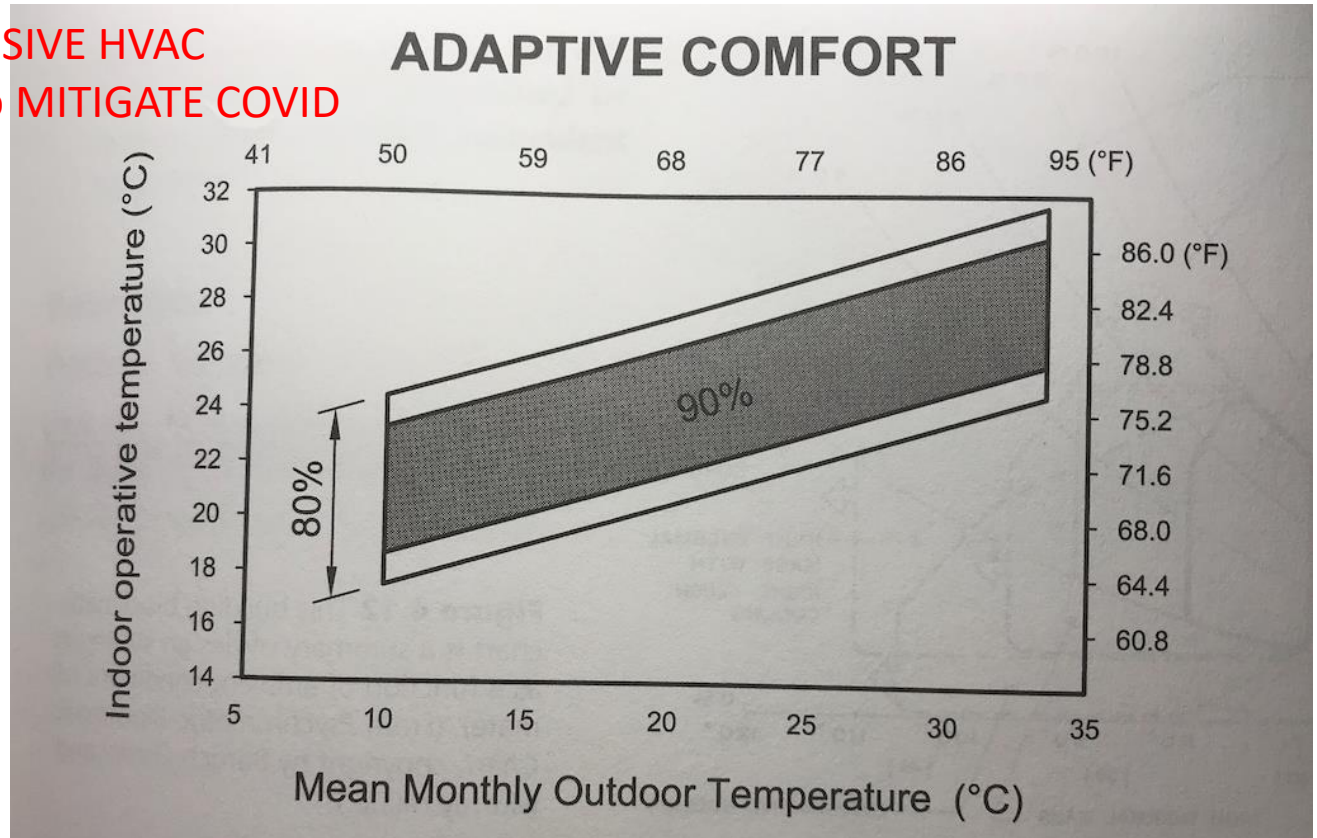
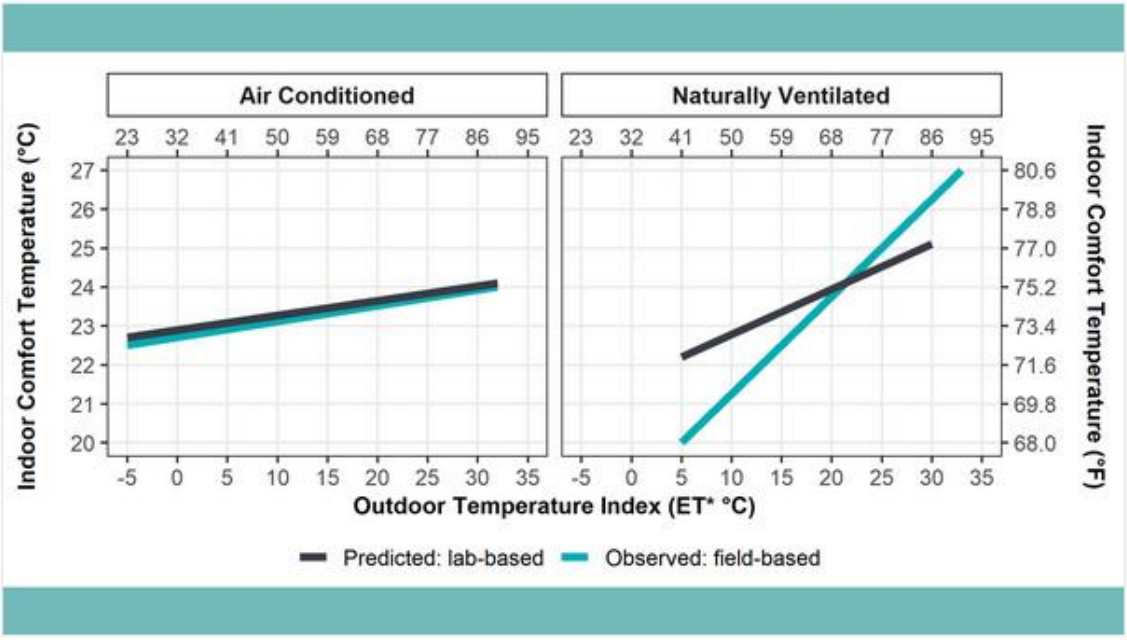


Figure 4.10 Under certain circumstances, people can be comfortable in conditions that fall outside the traditional comfort zone. In naturally ventilated buildings and where occupants have some control over their environment, the adaptive comfort zone increases along with the outdoor temperature. Operative temperature includes both air temperature and MRT.

JT Wunderlich PhD

https://cbe.berkeley.edu/research/adaptive-comfort-model/

RESEARCH
Indoor Environmental Quality
IEQ measurement
Productivity
Fans
Personal comfort systems
Thermal comfort
Acoustics
HVAC Systems
Facade Systems
Case studies
Operable windows
Mixed-mode systems
Adaptive comfort
Natural ventilation
Human Interactions



Adaptive Comfort Model

A standard for thermal comfort in naturally ventilated buildings included in ASHRAE Standard 55.

STATUS: COMPLETED

FUNDING SOURCES: ASHRAE 884-RP

Project Objective

Examine the applicability of Fanger's predicted mean vote (PMV) model in naturally ventilated buildings, and develop an adaptive comfort model based on world-wide field data.

Project Results

The results of this research form the basis of the Adaptive Comfort Model that was adopted in the 2004 version of the ASHRAE Standard 55.

> *The Adaptive Comfort Model has become the global standard for designing and operating naturally-ventilated buildings and has led to energy savings worldwide.*

Significance to Industry

It was previously very difficult for a naturally ventilated building to stay within the narrow comfort range prescribed by ASHRAE 55, which is based on controlled settings in laboratory conditions that are not representative of many environments in real build
with operable windows. By creating an alternative comfort model more a
buildings, designers have greater flexibility to design buildings with opera
could both enhance comfort and reduce energy use.

The “Comfort Zone”
And Discomfort outside that zone

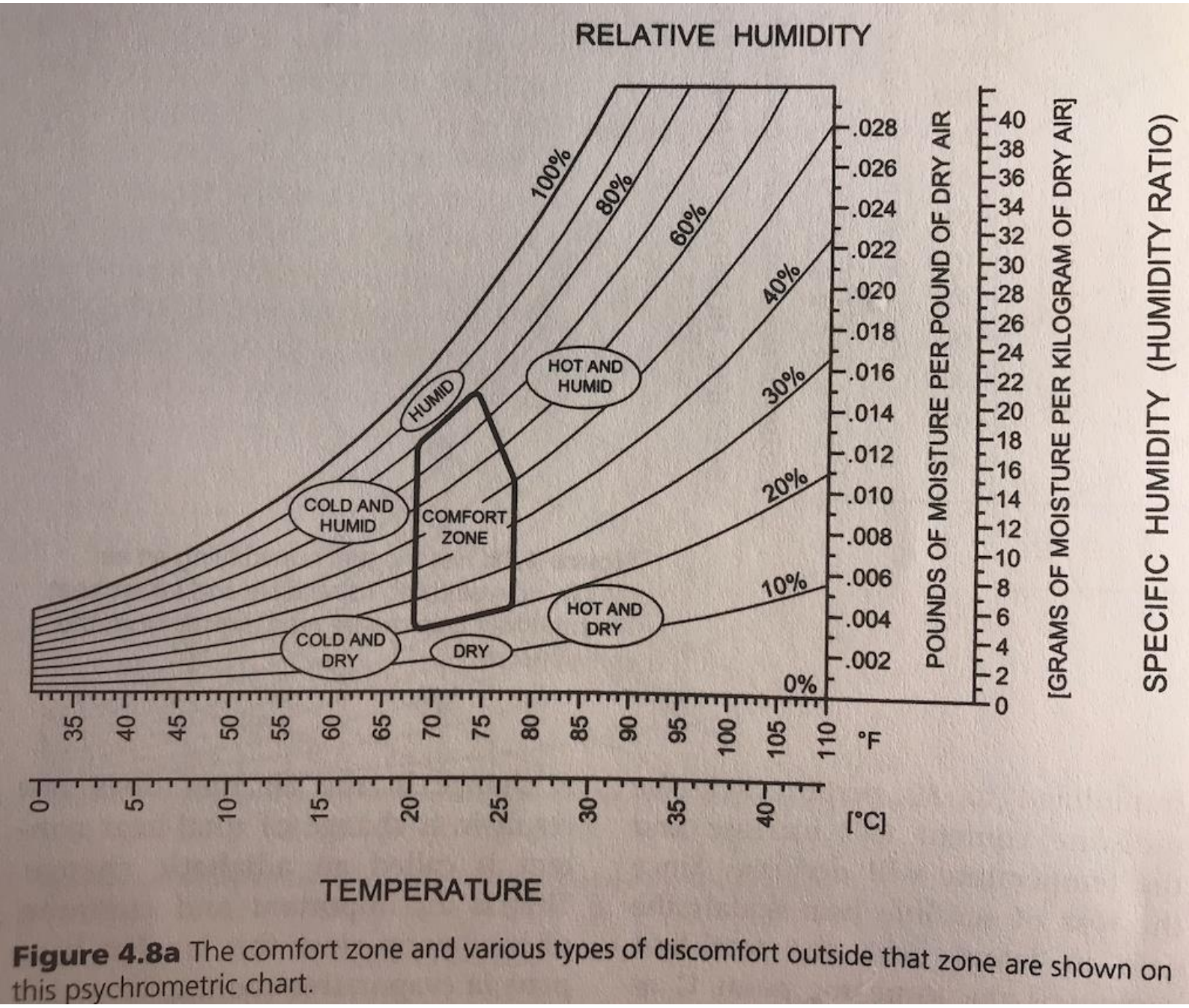
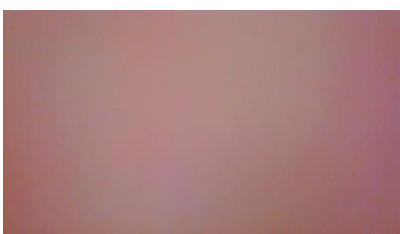
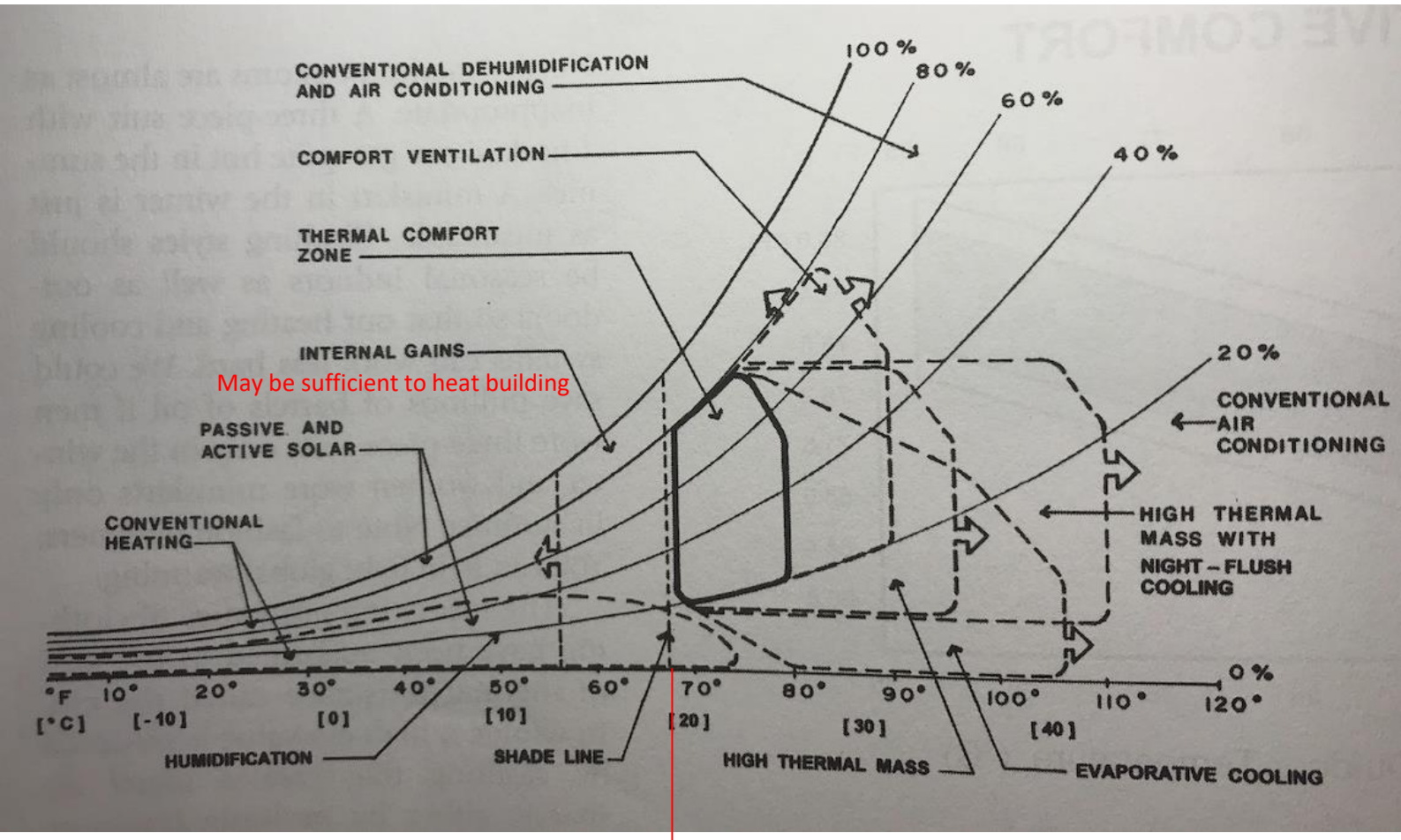


Figure 4.8a The comfort zone and various types of discomfort outside that zone are shown on this psychrometric chart.



JT Wunderlich PhD

The “Comfort Zone”
Design Strategies



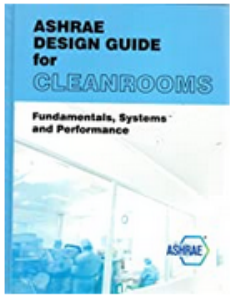
Prevent sun from entering building when temperatures above “Shade Line”

Read more:

[ASHRAE]

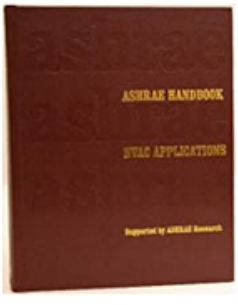
- **A**merican **S**ociety of **H**eating, **R**efrigeration, and **A**ir-conditioning Engineers
  - [Design Handbooks on-line]
  - [Design Handbook Hardcopies]:

2018 International Energy Conservation Code with ASHRAE Standard (International Code Council Series)
by International Code Council | Nov 7, 2017
★★★★★ 31
Paperback
$155.62 ~~$166.00~~
prime Get it as soon as **Mon, Oct 5**
FREE Shipping by Amazon
Only 6 left in stock (more on the way).
More Buying Choices
$148.52 (10 used & new offers)



ASHRAE Design Guide for Cleanrooms: Fundamentals, Systems, and Performance
by Ashrae | Jan 1, 2018
Hardcover
$171.00
prime Get it as soon as **Tomorrow, Oct 3**
FREE Shipping by Amazon
Only 9 left in stock (more on the way).
More Buying Choices
$69.00 (6 used & new offers)

2017 ASHRAE Handbook -- Fundamentals (IP) - (includes CD in I-P and SI editions) (Ashrae Handbook Fundamentals Inch-Pound System)
by Ashrae | Jun 5, 2017
★★★★★ 10
Hardcover
$220.00
prime Get it as soon as **Tomorrow, Oct 3**
FREE Shipping by Amazon
Only 11 left in stock (more on the way).
More Buying Choices
$178.99 (11 used & new offers)
Multimedia CD
$230.00
prime Get it as soon as **Wed, Oct 7**
FREE Shipping by Amazon
Only 2 left in stock (more on the way).



2019 ASHRAE Handbook -- HVAC Applications (I-P) (ASHRAE Applications Handbook Inch/Pound)
by Ashrae | Jun 1, 2019
Hardcover
$230.00
prime Get it as soon as **Sun, Oct 4**
FREE Shipping by Amazon
Only 5 left in stock (more on the way).
More Buying Choices
$152.98 (12 used & new offers)

[ASHRAE]

- **A**merican **S**ociety of **H**eating, **R**efrigeration, and **A**ir-conditioning Engineers
  - Design Handbooks on-line
  - Design Handbook Hardcopies:

2017 ASHRAE Handbook -- Fundamentals (IP) - (includes CD in I-P and SI editions) (Ashrae Handbook Fundamentals Inch-Pound System)

by Ashrae | Jun 5, 2017

★★★★★ 10

Hardcover

$220.00

prime Get it as soon as **Tomorrow, Oct 3**

FREE Shipping by Amazon

Only 11 left in stock (more on the way).

A&E Case Study of BOTH Architecture and Engineering:

From Romance to Performance: Assessing the Impacts of Jali Screens on Energy Savings and Daylighting Quality of Office Buildings in Lahore, Pakistan

December 2014

https://www.researchgate.net/publication/313512852_From_Romance_to_Performance_Assessing_the_Impacts_of_Jali_Screens_on_Energy_Savings_and_Daylighting_Quality_of_Office_Buildings_in_Lahore_Pakistan

Conference: 30th INTERNATIONAL PLEA CONFERENCE · At: Ahmedabad, India

Authors:

Ihab Elzeyadi
7.37 · University of Oregon

Ayesha Batool
University of Nottingham

Download citation | Copy link

Citations (6) References (21) Figures (1)

Abstract and Figures

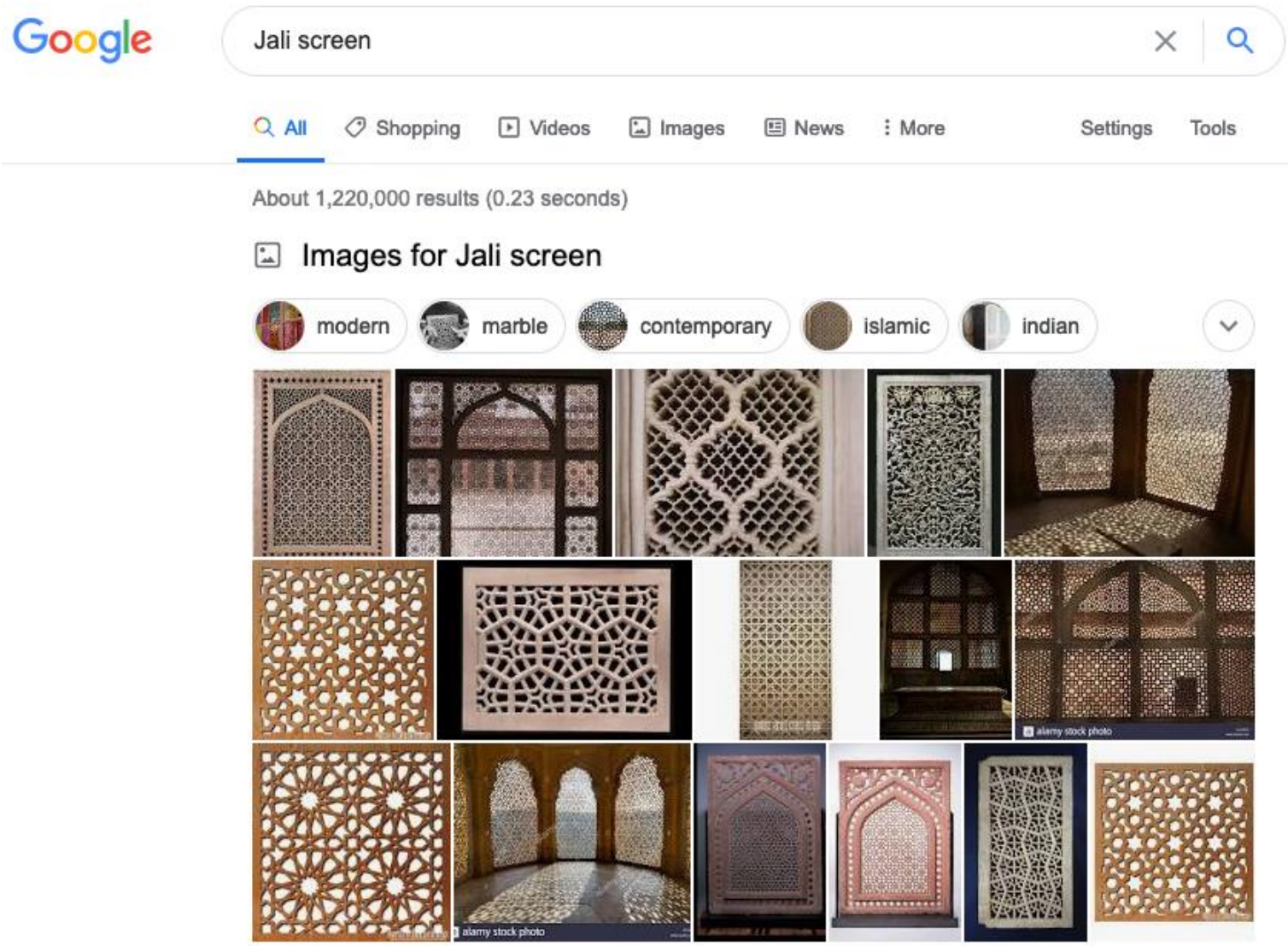
Jali Screens are traditional window treatments used in vernacular buildings throughout South Asia and the Middle East. Historically, the screen treatments are successful in providing shade and privacy for building occupants in hot arid and hot humid climates. With interest in traditional building features, recent trends in contemporary buildings design have started to incorporate Jali screens or other screens as decorative façade elements. However, the use of these screens has been widely approached from the aesthetic and romantic attitude representing an architectural fascination with the vernacular. Their impact on overall building energy and daylighting performance, however, has been largely ignored. This paper reports

A&E Case Study of BOTH Architecture and Engineering:

From Romance to Performance: Assessing the Impacts of Jali Screens on Energy Savings and Daylighting Quality of Office Buildings in Lahore, Pakistan

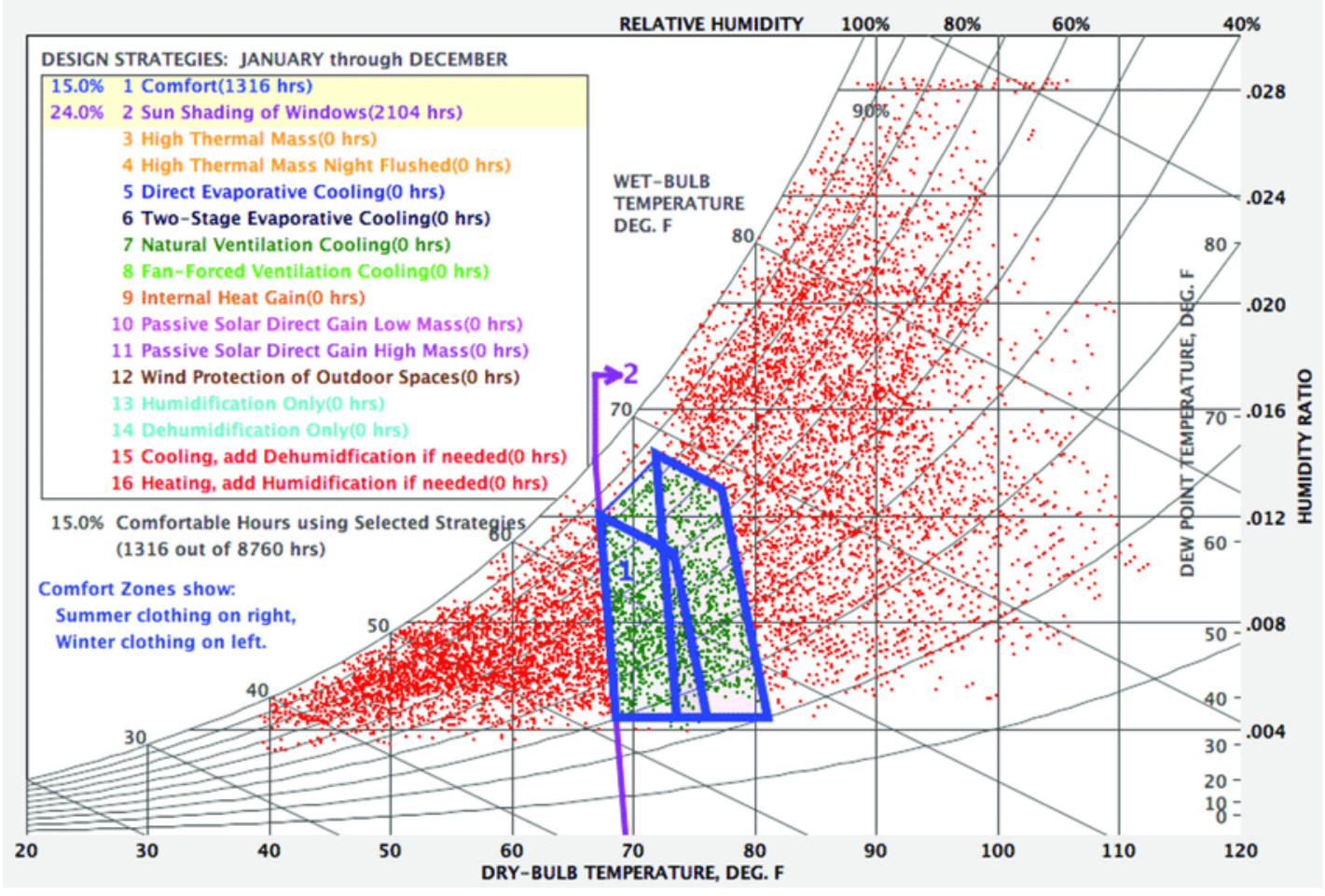
Jali Screens are traditional window treatments used in vernacular buildings throughout South Asia and the Middle East. Historically, the screen treatments are successful in providing shade and privacy for building occupants in hot arid and hot humid climates. With interest in traditional building features, recent trends in contemporary buildings design have started to incorporate Jali screens or other screens as decorative façade elements. However, the use of these screens has been widely approached from the aesthetic and romantic attitude representing an architectural fascination with the vernacular. Their impact on overall building energy and daylighting performance, however, has been largely ignored. This paper reports ...

https://www.researchgate.net/publication/313512852_From_Romance_to_Performance_Assessing_the_Impacts_of_Jali_Screens_on_Energy_Savings_and_Daylighting_Quality_of_Office_Buildings_in_Lahore_Pakistan



A&E Case Study of BOTH Architecture and Engineering:

From Romance to Performance: Assessing the Impacts of Jali Screens on Energy Savings and Daylighting Quality of Office Buildings in Lahore, Pakistan



https://www.researchgate.net/publication/313512852_From_Romance_to_Performance_Assessing_the_Impacts_of_Jali_Screens_on_Energy_Savings_and_Daylighting_Quality_of_Office_Buildings_in_Lahore_Pakistan

JT Wunderlich PhD

GOTO THIS SITE (out of class time) and click on chart, and buttons:
http://www.flycarpet.net/en/PsyOnline

Home About Projects Contact

Free Online Interactive Psychrometric Chart A convenient, precise and customizable psychrometric chart & calculator tool for HVAC engineers. Support IP and SI units.

Basic | Process | Cycle 1 | Cycle 2 | Setting | Display | 简体中文

Click on chart for air properties

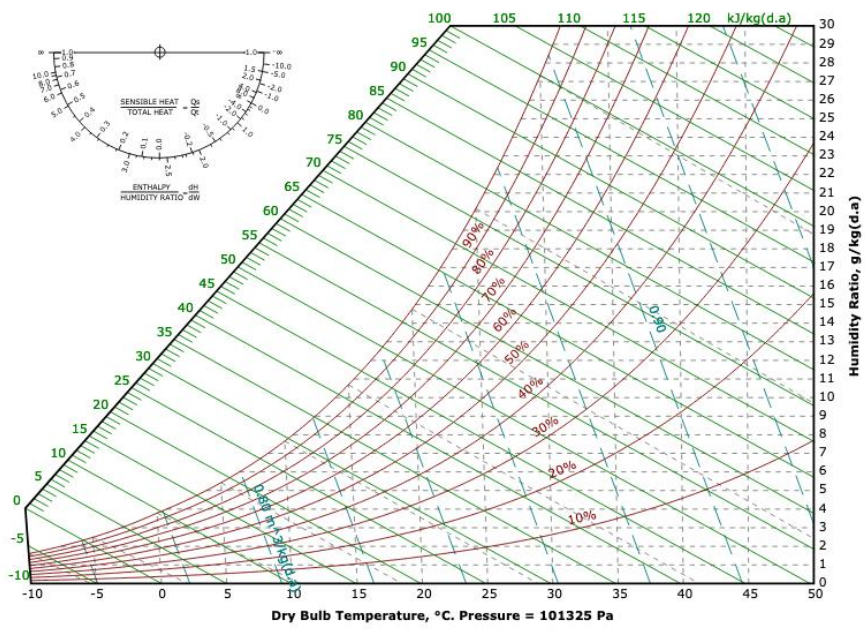
Or input data for air properties

T.Dry, °C 25

Rel.Humid, % 50

Quantity	Value	Units
P.Ambient		Pa
T.Dry.Bulb		°C
Humid.Ratio		g/kg(d.a)
Rel.Humid		%
T.Wet.Bulb		°C
T.Dew		°C
T.Saturation		°C
Enthalpy		kJ/kg(d.a)
P.Vapour		Pa
P.Sat.Vapour		Pa
Spec.Heat		kJ/(kg.K)
Spec.Volume		m^3/kg(d.a)
Density		kg/m^3

Submit



Tweet

Desktop Version

For windows, without network and browser limits. Click following button to download the software with 30 days full functional free trial, or pay $65 to get up to 3 license keys.

Download V4.41

Buy Now

Related Links

Wikipedia Psychrometrics