

Refrigeration & Air Conditioning Technology

SIXTH EDITION

SECTION 7

AIR CONDITIONING (COOLING)

UNIT 35

COMFORT AND PSYCHROMETRICS

UNIT OBJECTIVES

After studying this unit, the reader should be able to

- Recognize the four factors involved in comfort.
- Explain the relationship of body temperature to room temperature.
- Describe why one person is comfortable when another is not.
- Define psychrometrics.
- Define wet-bulb and dry-bulb temperature.
- Define dew point temperature.

Refrigeration & Air Conditioning Technology

SIXTH EDITION

UNIT OBJECTIVES

After studying this unit, the reader should be able to

- Explain vapor pressure of water in air.
- Describe humidity.
- Plot air conditions using a psychrometric chart.

Refrigeration & Air Conditioning Technology

SIXTH EDITION

COMFORT

- Comfort describes a delicate balance of pleasant feelings in the body produced by its surrounding
- Comfort involves
 - Temperature
 - Humidity
 - Air movement
 - Air cleanliness
- The human body makes adjustments to comfort conditions by its circulatory and respiratory systems

FOOD, ENERGY, AND THE BODY

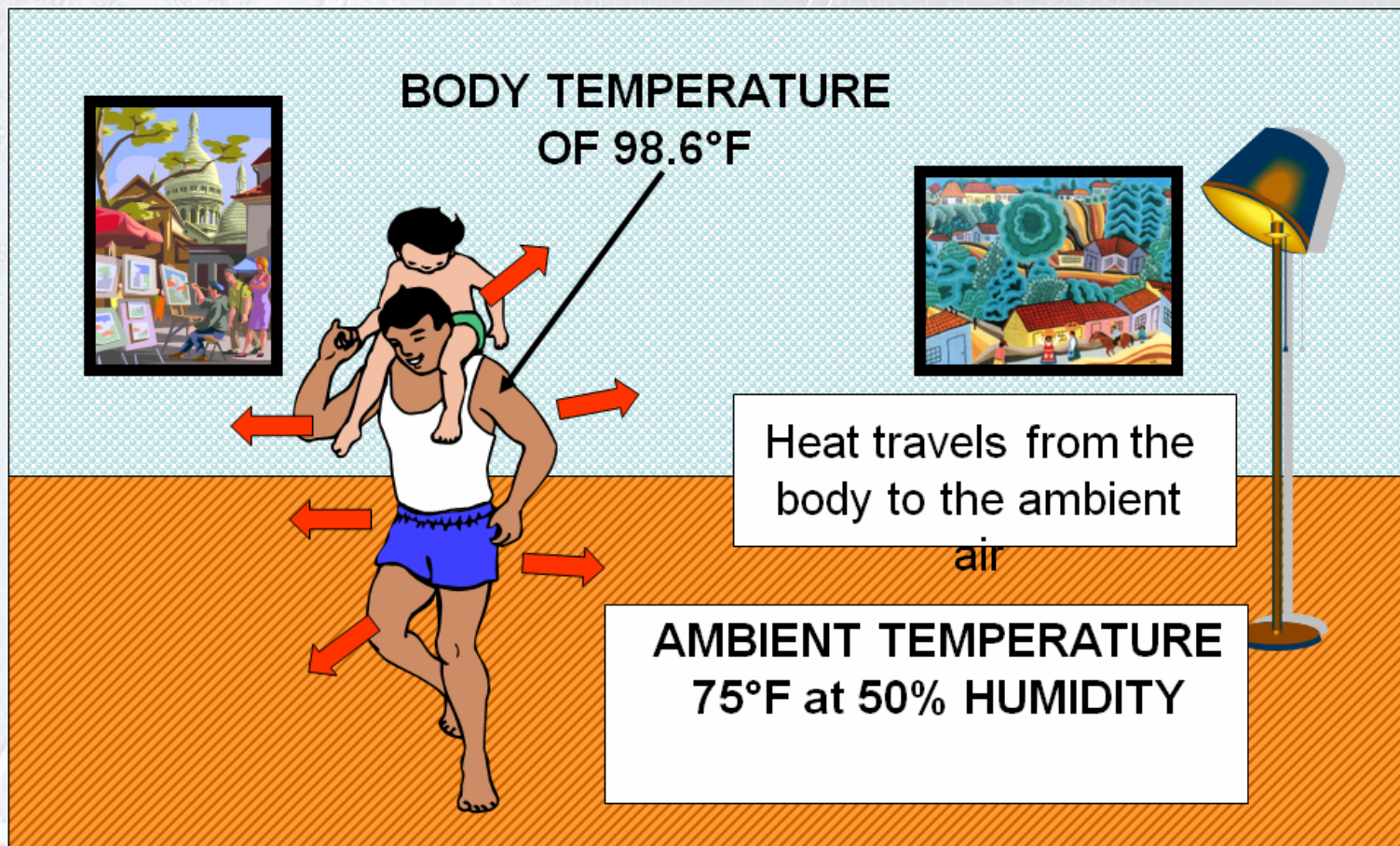
- The body uses food to produce energy
- The body energy
 - Some stored as fatty tissue
 - Some leaves as waste
 - Some leaves as heat
 - Some is used to keep the body functioning

BODY TEMPERATURE

- Humans are comfortable when the heat is transferring to the surroundings at the correct rate
- The body gives off and absorb heat by conduction, convection and radiation
- Surroundings must be cooler than the body for the body to be comfortable
- The body is close to being comfortable when it is at rest and in surroundings of 75°F and 50% humidity with slight air movement
- Comfort conditions in winter and in summer are different

Refrigeration & Air Conditioning Technology

SIXTH EDITION



Refrigeration & Air Conditioning Technology

SIXTH EDITION



Outside ambient
temperature 100°F

The body cannot give up heat
readily

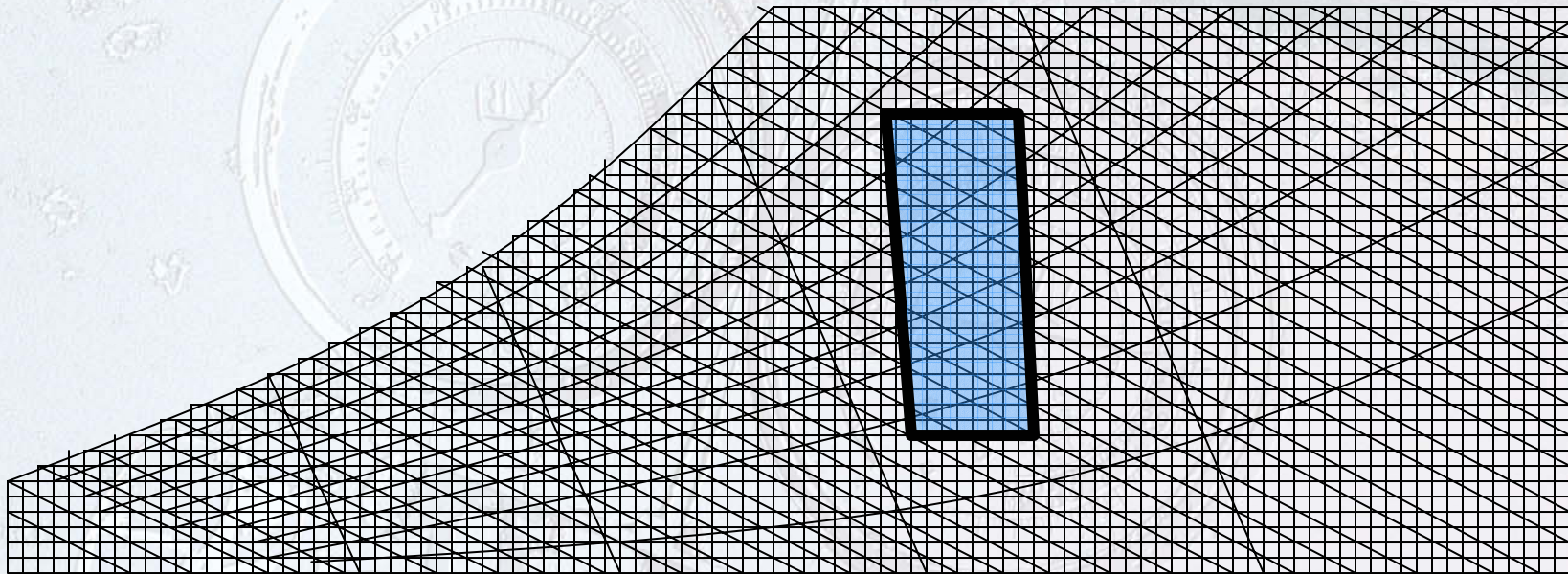
THE COMFORT CHART

- Can be used to compare one comfort situation or condition with another
- Shows the different combinations of temperature and humidity for summer and winter
- The closer the plot falls to the middle of the chart, the more people would be comfortable
- Different charts for summer and winter conditions

Refrigeration & Air Conditioning Technology

SIXTH EDITION

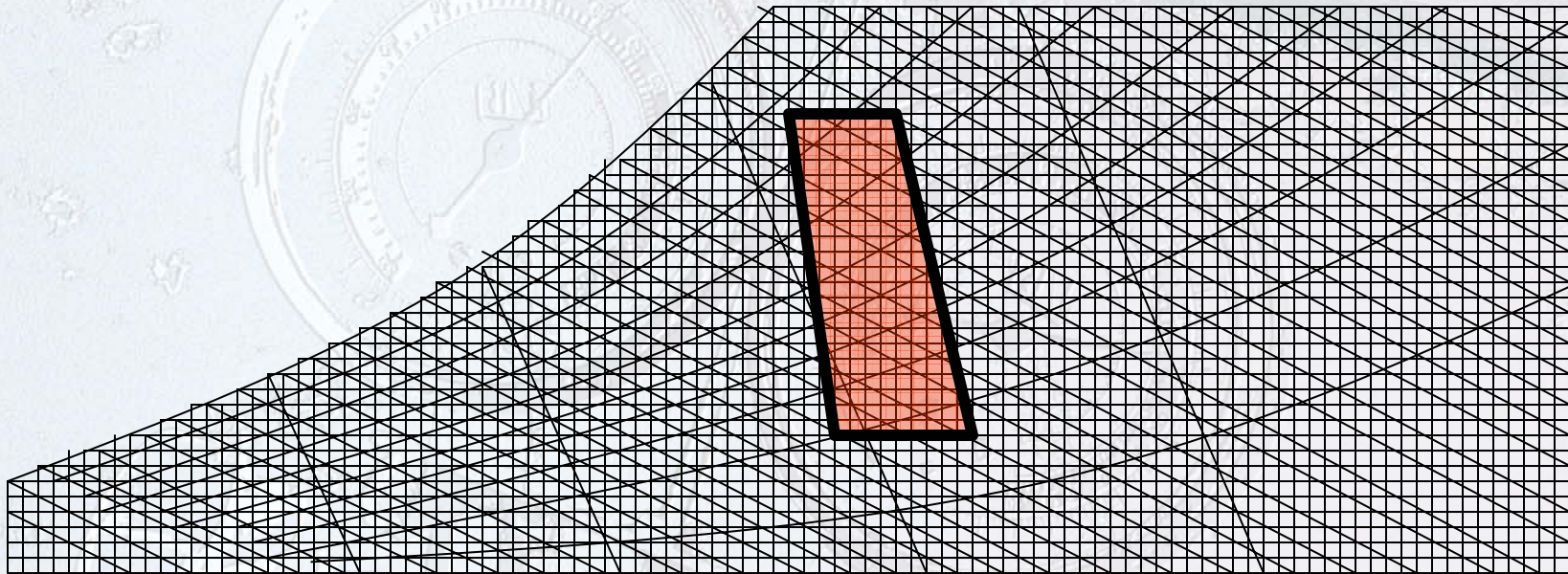
SAMPLE COMFORT CHART FOR SUMMER MONTHS



Refrigeration & Air Conditioning Technology

SIXTH EDITION

SAMPLE COMFORT CHART FOR WINTER MONTHS



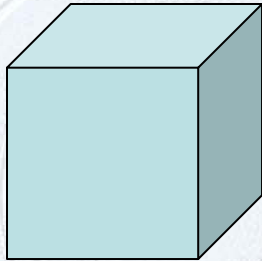
PSYCHROMETRICS

- The study of air and its properties
- Air has weight and occupies space
- Air weighs about 0.075 lbs per cubic foot
- One pound of 70°F air occupies about 13.33 cubic feet
- The number of cubic feet of air it takes to make a pound of air can be obtained by taking the reciprocal of the density of the air

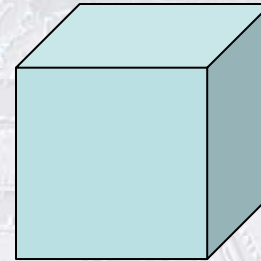
Refrigeration & Air Conditioning Technology

SIXTH EDITION

DENSITY



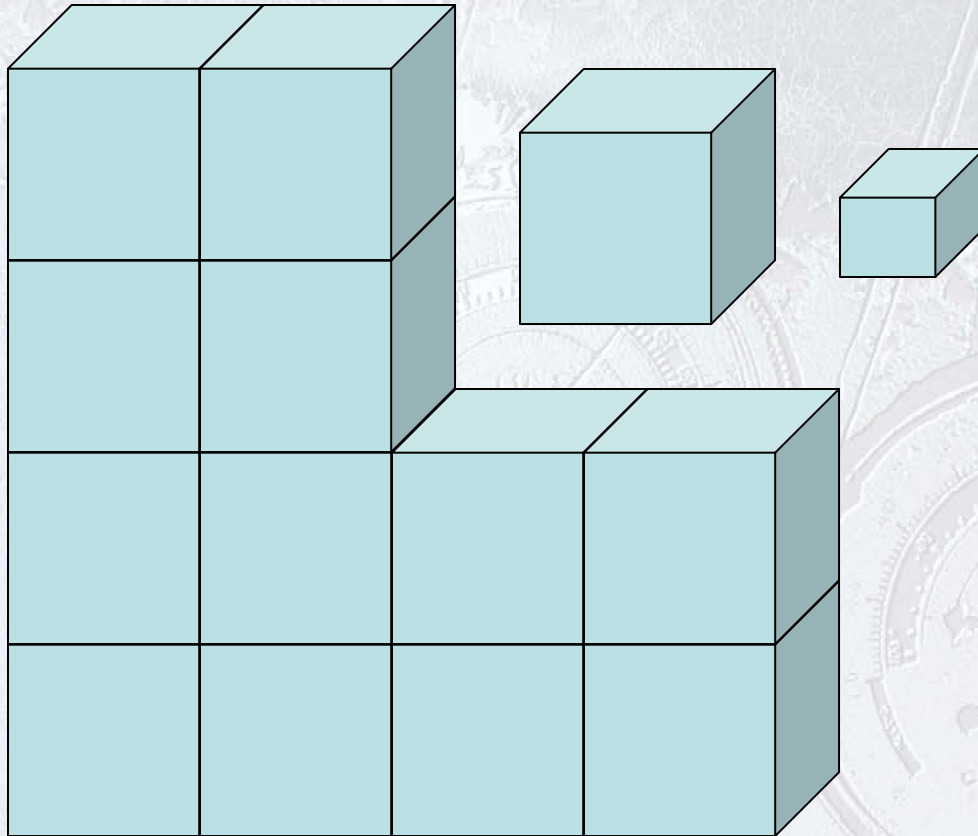
1 cubic foot of air
weighs about 0.075
pounds at 70°F



1 cubic foot of water
weighs about 62.4
pounds at 70°F

Refrigeration & Air Conditioning Technology

SIXTH EDITION



It will take about
13.33 cubic feet of air
to make one pound

The specific volume of air
is equal to 13.33 cubic feet

$$1/0.075 = 13.33$$

SPECIFIC VOLUME = 1/DENSITY

MOISTURE IN AIR AND HUMIDITY

- There is water in air at all times
- Moisture in air is called humidity
- Moisture in the air is measured by weight
- There are 7,000 grains of moisture in one pound of water
- Relative humidity is the weight of water vapor in a pound of air compared to the maximum amount of water vapor that a pound of air could hold

Refrigeration & Air Conditioning Technology

SIXTH EDITION

HUMIDITY LINES



DRY-BULB AND WET-BULB TEMPERATURES

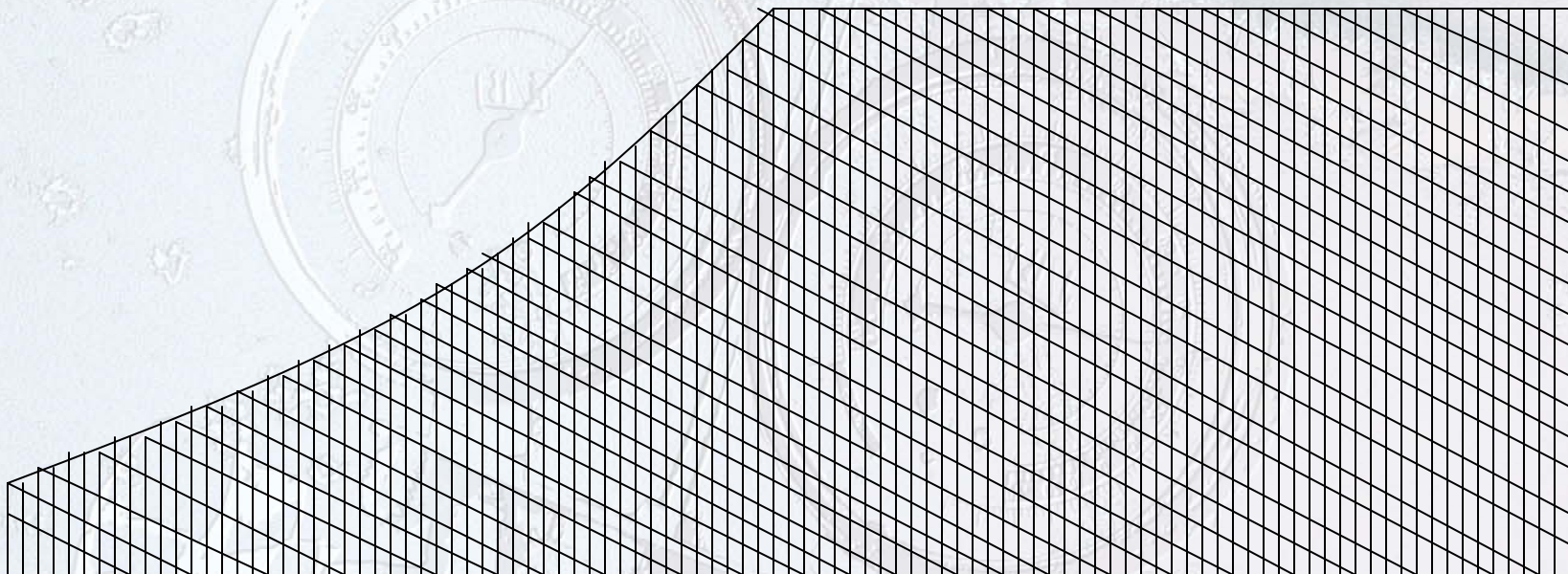
- The moisture content of air can be checked by using a combination of dry-bulb and wet-bulb temperature
- Dry-bulb temperature is the sensible heat level in the air
- Wet-bulb temperature takes into account the moisture content of the air
- The difference between the dry-bulb reading and the wet-bulb reading is called the wet-bulb depression
- Saturation is the point at which the air is holding all the moisture it can

Refrigeration & Air Conditioning Technology

SIXTH EDITION

Vertical lines = Dry-bulb temperatures

Angled lines = Wet-bulb temperatures

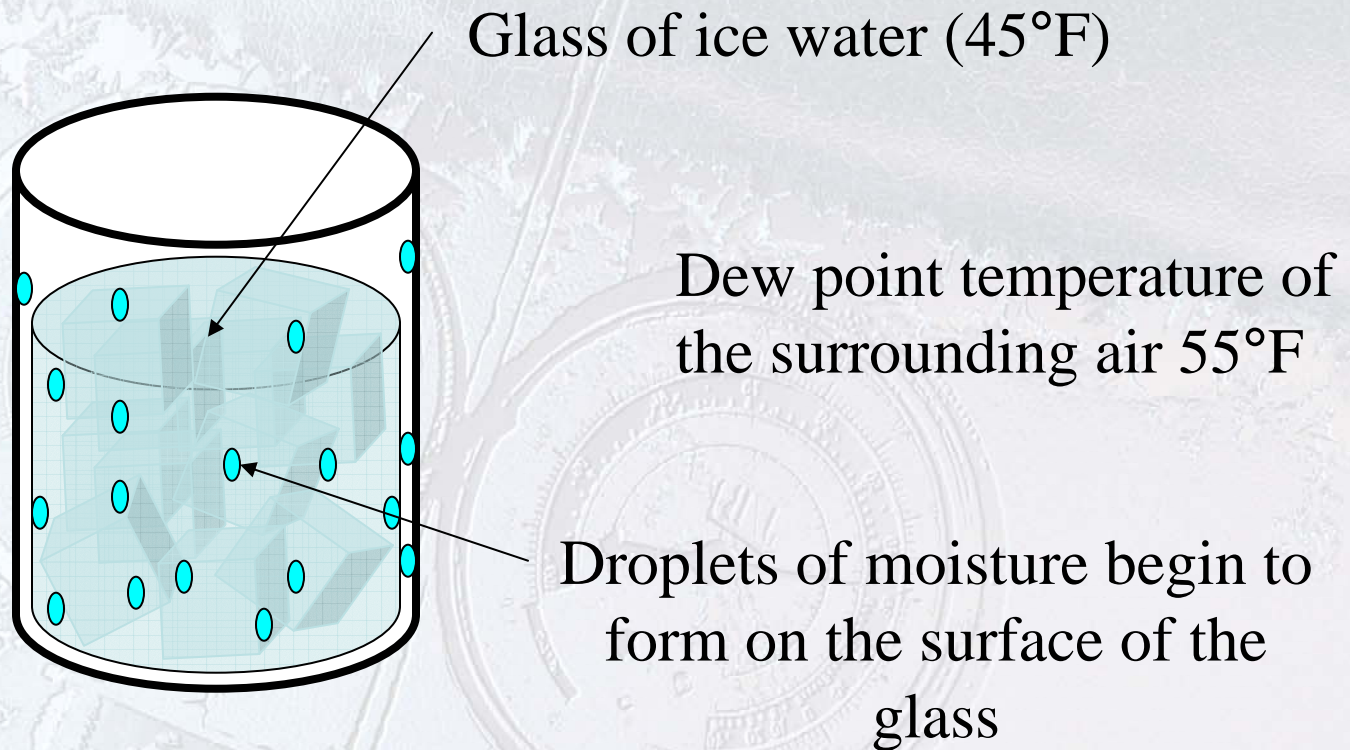


DEW POINT TEMPERATURE

- The temperature at which the moisture in the air begins to condense out of the air
- The temperature at which water forms on objects from the air is called the dew point temperature of the air
- The evaporator in an air conditioning or refrigeration system operates below the dew point temperature, so, as air comes in contact with the coil, moisture begins to condense out of the air

Refrigeration & Air Conditioning Technology

SIXTH EDITION

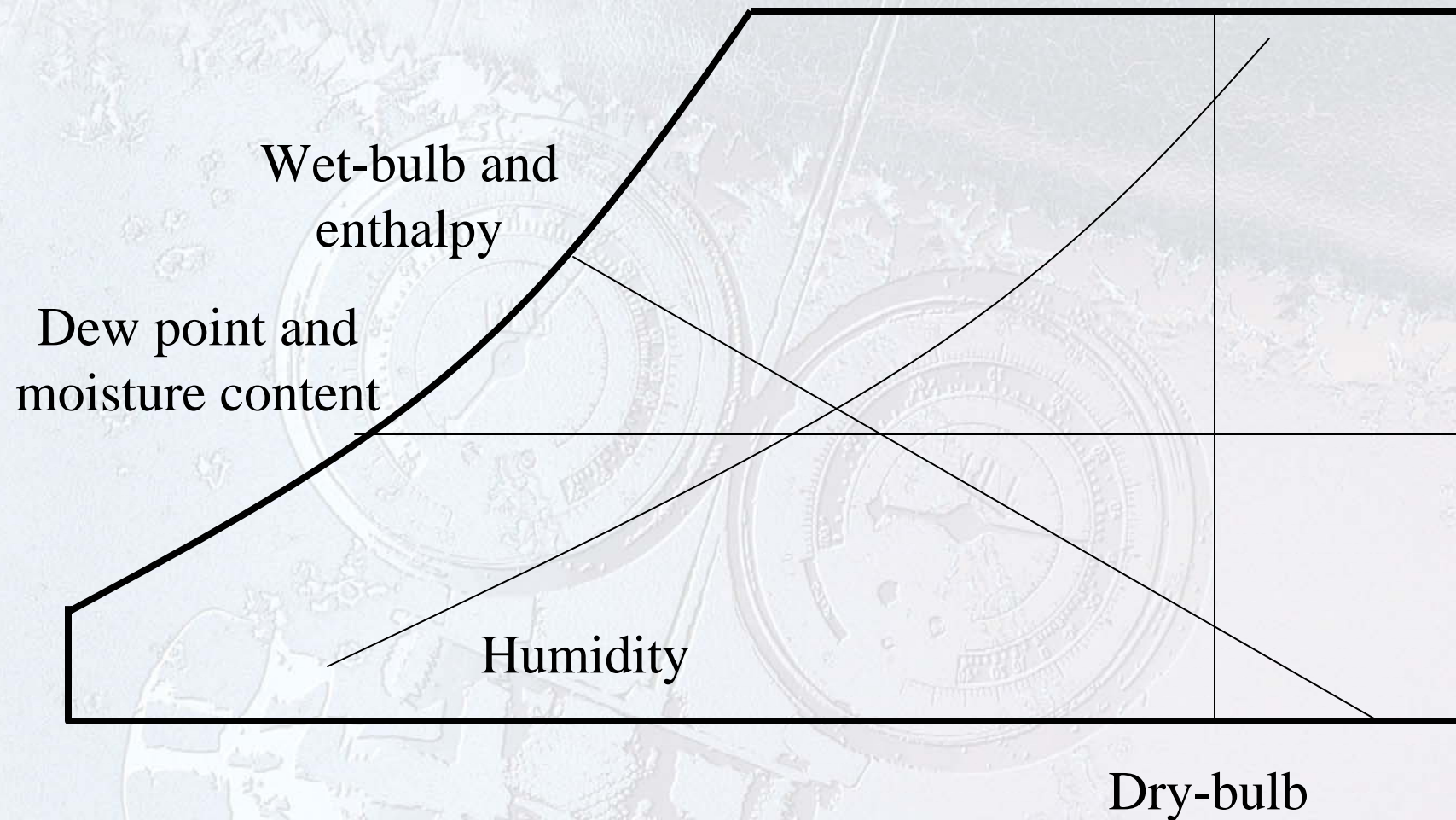


THE PSYCHROMETRIC CHART

- Provides a graphical representation of air and its properties
- Knowing any two conditions of air allows the other conditions of the air to be found
- Lines on the psychrometric chart
 - Dry-bulb and wet-bulb temperature lines
 - Relative humidity lines
 - Grains of moisture lines
 - Total heat lines (enthalpy)
 - Cubic feet lines

Refrigeration & Air Conditioning Technology

SIXTH EDITION



TOTAL HEAT

- The capacity of a heating and cooling unit may be field checked with the total heat feature of the psychrometric chart
- Total heat = sensible heat + latent heat
- Sensible heat formula: $Q_s = 1.08 \times \text{cfm} \times \text{TD}$
- Total heat formula: $Q_t = 4.5 \times \text{cfm} \times \text{total heat difference}$
- CFM formula:
$$\frac{Q_s}{1.08 \times \text{TD}}$$

Refrigeration & Air Conditioning Technology

SIXTH EDITION

SUMMARY - 1

- Comfort is affected by air movement, humidity, air cleanliness and temperature
- Humans are considered to be comfortable when heat is transferred from the body to its surroundings at the proper rate
- The body is close to being comfortable when it is at rest and in surroundings of 75°F and 50% humidity with slight air movement
- The comfort chart is used to compare one comfort situation or condition with another

Refrigeration & Air Conditioning Technology

SIXTH EDITION

SUMMARY - 2

- Psychrometrics is the study of air and its properties
- Density indicates how many pounds one cubic foot of a substance weighs
- Specific volume is the reciprocal of density
- Moisture in air is referred to as humidity
- Dry bulb temperature is the sensible heat level of air
- Wet bulb temperatures take the moisture content of the air into account

Refrigeration & Air Conditioning Technology

SIXTH EDITION

SUMMARY - 3

- The dew point temperature is the point at which moisture in the air begins to condense out of the air
- The psychrometric chart provides a graphical representation of an air sample as well as a means to calculate other properties of the air
- Total heat = sensible heat + latent heat