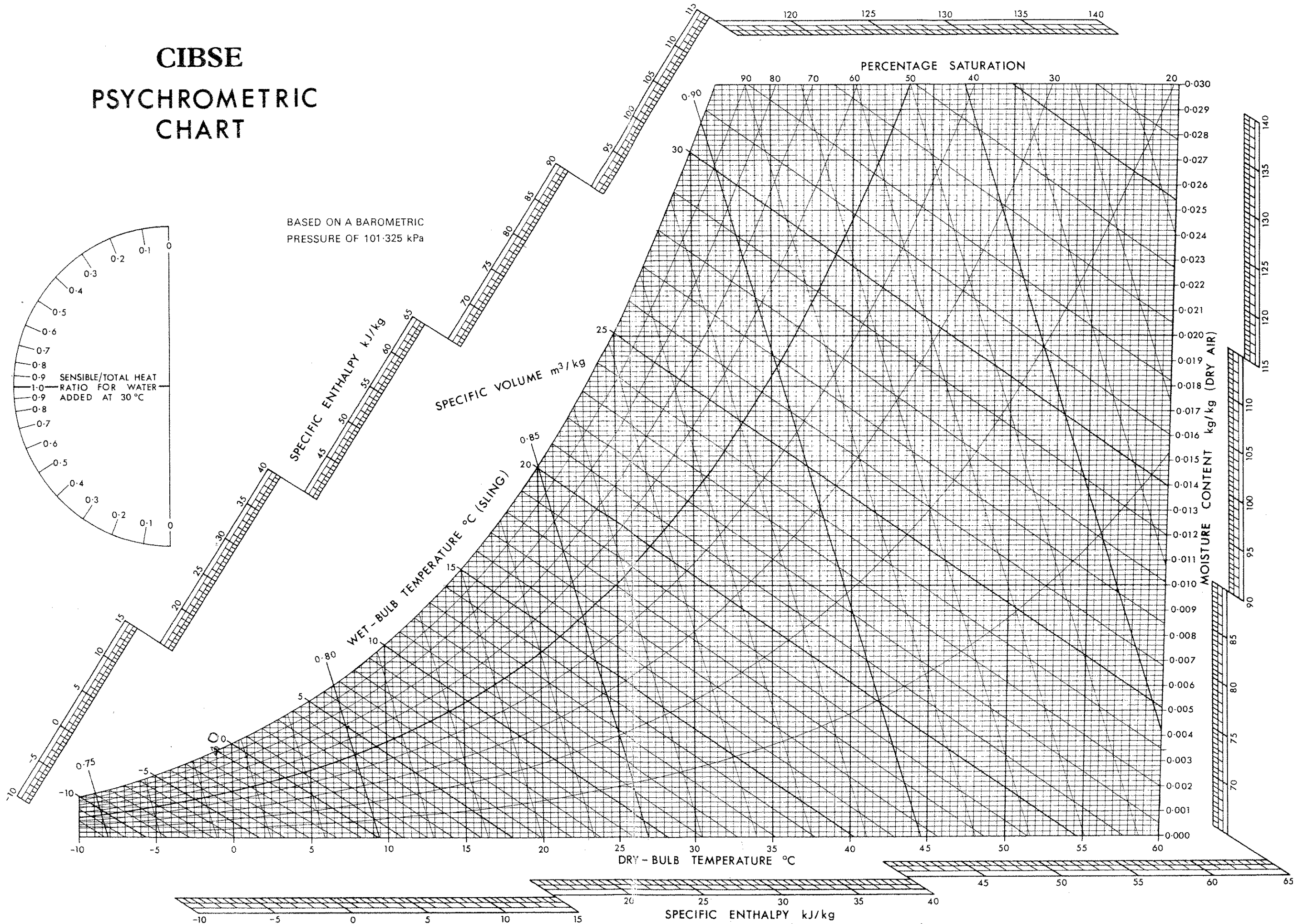
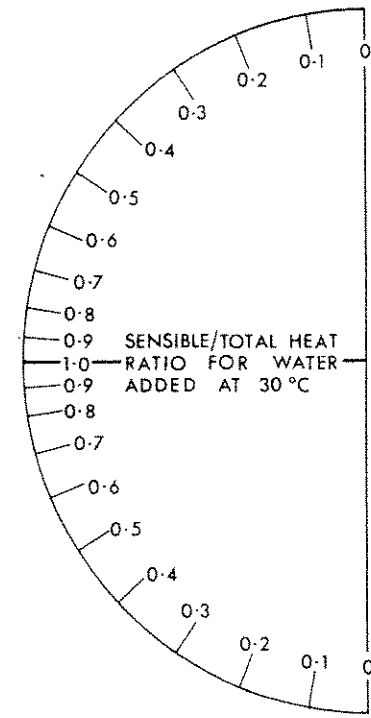


CIBSE PSYCHROMETRIC CHART

BASED ON A BAROMETRIC
PRESSURE OF 101.325 kPa



DIRECTIONS FOR USING THE TRANE PSYCHROMETRIC CHART



- Skeleton Psychrometric Chart
1. Dry bulb temperature line
 2. Moisture content line
 3. Moisture content scale
 4. Wet bulb temperature line.
 5. Specific volume line.
 6. Enthalpy scale
 7. Relative humidity line
 8. Sensible heat factor scale
 9. Enthalpy deviation from saturation.

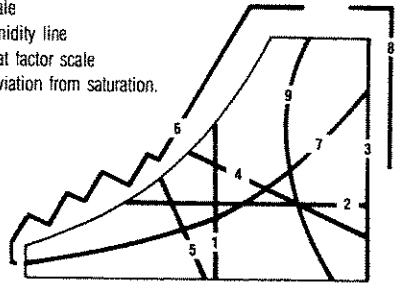


FIGURE 1

The following definitions are referenced in Figure 1.

1. Dry Bulb Temperature: The temperature of air read on a standard thermometer and shown on the chart by straight vertical lines. Scale is at bottom of chart. Unit — degree C, abbreviated DB.
2. Wet Bulb Temperature: The wet bulb temperature above 0° C is the temperature indicated by a thermometer whose bulb is covered by a wet wick and exposed to a stream of air moving at a velocity of 5 meters per second. Wet bulb temperatures below 0° C are obtained from a thermometer on which the water in the wick has frozen to ice. This is the reason the slope of the wet bulb temperature lines changes below 0° C. Scale is on curved line at left edge of chart. Unit — degree C, symbol — WB.
3. Moisture Content: The mass of water vapor in each kg of dry air. This is also known as specific humidity. On the chart, these lines are straight horizontal lines at right angles to the dry bulb lines. The units used are kg of moisture per kg of dry air. Symbol is W.
4. Enthalpy: A thermodynamic property which serves as a measure of the heat energy in a system above some datum temperature, for air 0° C and water 0° C. In this case, it represents the energy in one kg of dry air and W kg's of moisture associated with it. Units — kJ per kg of dry air, symbol — h.
5. Specific Volume: The cubic meter of the mixture per kg of dry air, symbol — v.
6. Relative Humidity: The ratio of the mol fraction of water vapor in a mixture to the mol fraction of water vapor in saturated air at the same dry bulb temperature and barometric pressure. Unit — percent, symbol — Greek letter phi (Φ) or RH.
7. Sensible Heat Ratio: The ratio of the sensible heat to total heat in a process. Units — none, Symbol — SHR.
8. Standard Barometric Pressure: The chart has been made up for standard sea level barometric pressure of 101.325 kPa absolute.
9. Enthalpy Deviation — The amount by which the enthalpy of the air mixture deviates from specific enthalpy at saturation.

Illustrative Examples:

Problem 1: Given room condition of 24° DB and 50% relative humidity. For the air vapor mixture find:

- Wet bulb temperature
- Moisture content
- Enthalpy
- Specific volume
- Percentage humidity

Answers:

Locate the point where the vertical line representing 24 DB and the curve line representing 50% relative humidity intersect. From this point, read all of the other values.

- Follow the diagonal line up to the left until it intersects the wet bulb temperature scale. Read 17° C.
- Follow the horizontal line to the right until it intersects the moisture content scale. Read .0092 kg of moisture per kg of dry air.
- Read the specific enthalpy on the enthalpy scale of 47.95 kJ/kg dry air by following the Wet Bulb Line to the enthalpy scale. Apply the enthalpy deviation factor of — .21 kJ/kg from the location of the point on the enthalpy deviation scale. Actual enthalpy equals 47.95 — .21 = 47.74 kJ/kg dry air.
- Interpolate between specific volume lines. Read .855 cubic meters per kg of dry air.
- Percentage humidity equals actual moisture content (found in Step b) divided by moisture content at saturation for same DB temperature. At 24 C DB and 100% RH read W = .0188.

$$\text{Percentage humidity} = \frac{.0092}{.0188} = .489$$

Air Conditioning Process

- A - Humidifying Only
- B - Heating and Humidifying
- C - Sensible Heating Only
- D - Chemical Dehumidifying
- E - Dehumidifying Only
- F - Cooling and Dehumidifying
- G - Sensible Cooling Only
- H - Evaporative Cooling Only

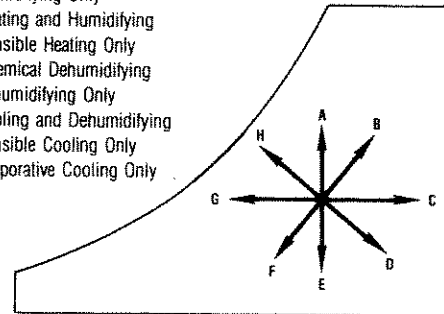


FIGURE 2

Problem 2: Given air at 28 C DB and 15 C WB. Refer to Figure 2. Determine:

- Enthalpy
- Moisture content
- Relative humidity

Determine the point of intersection between the vertical line for 28 C DB and the sloping line for 15 C WB

- Follow the 15 C WB Line to the specific enthalpy scale. Read 42.1 kJ/kg dry air. Read correction of — .35 kJ/kg dry air. Therefore enthalpy is 42.1 — .35 = 41.75 kJ/kg.
- Follow the horizontal line to the right. Read .0053 kg of moisture per kg of dry air on the moisture content scale.
- Staying on the 28 C DB line, interpolate between the relative humidity lines above and below the point. Read 23.0% RH.

Problem 3: Mixture of Air

Given 3 m³/s of chilled air at 14° C DB and 13° C WB mixed with 1 m³/s of outside air at 35° C DB and 25° C WB. Use Figure 3 as a reference.

Find: The properties of mixture

Solution: Locate points for recirculated and outside air on the chart. Connect with a straight line. Read specific volumes of air at each point from chart. Convert m³/s of air to kg of air and find total weight of mixture.

$$\frac{3}{.825} = 3.64 \text{ kg/s}$$

$$\frac{1}{.895} = 1.12 \text{ kg/s}$$

$$\text{Dry bulb of mixture} = \frac{3.64}{4.76} \times 14 + \frac{1.12}{4.76} \times 35 = 18.9 \text{ C DB}$$

$$\frac{3.64}{4.76} \times 10.7$$

$$\frac{1.12}{4.76} \times 8.2$$

$$18.9 \text{ C DB}$$

From intersection of 18.9° C DB line with line between two points, read WB = 16.3° C, h = 46.0 kJ/kg after dry air convection, moisture content = .0105 kg of moisture per kg of dry air.

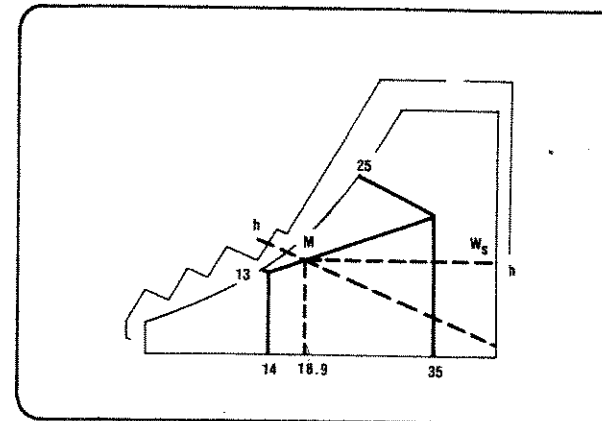


FIGURE 3

The following solution is an approximation which does not convert m³/s to kg/s

$$\frac{3}{4} \times 14 = 10.5$$

$$\frac{1}{4} \times 35 = 8.75$$

$$19.25 \text{ C DB mixture}$$

At the intersection of this Line with the Line between the two points, read WB = 16.5 C, h = 46.5 kJ/kg after correction, moisture content = .0106 kJ/kg Dry Air.

Problem 4: Sensible Heating Process Refer to Figure 4.

Given: Air at 2° C DB and 60% RH. Air is to be heated by passing through a coil to 35 C DB

Find: For the 35 C air, its percent RH and WB. For the process, the amount of heat added to the air per kg of air flowing

Solution: Locate the initial condition on the chart. Draw a horizontal line through the initial point to the 35 C DB line. Read 7.5% RH, WB = 15.2 C.

Find enthalpy of initial air as 8 kJ/kg = h₁

Find enthalpy of final air as 42.0 kJ/kg = h₂

Heat added equals difference 34.0 kJ/kg

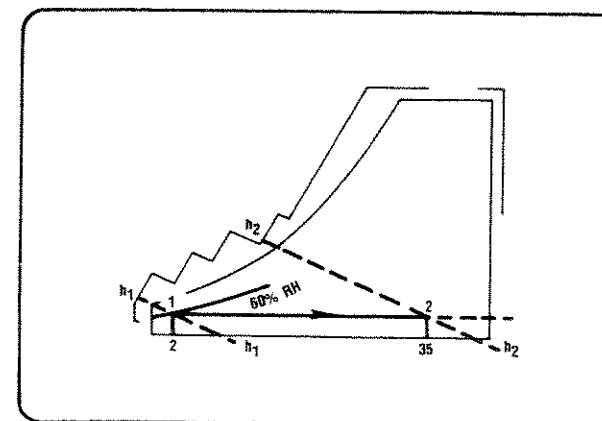


FIGURE 4

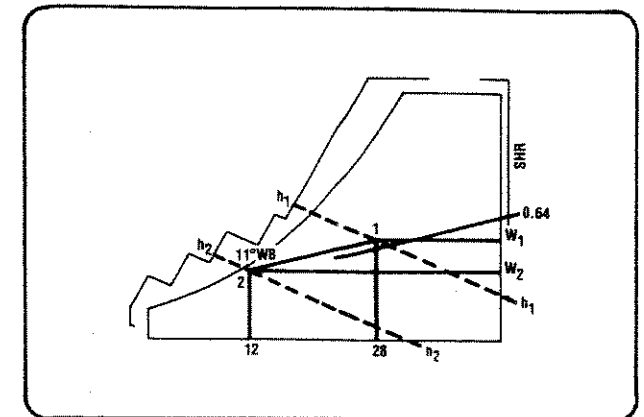


FIGURE 5

Problem 5: Cooling and Dehumidifying Refer to Figure 5.

Given: Air at 28 C DB and 50% RH being cooled to 12 C DB and 11 C WB

Find: Total heat removed
Total moisture removed
Sensible heat ratio for the process

Solution: Locate the initial and final conditions on the chart.

For the initial condition read W₁ = .0118

$$h_1 = 58.7$$

For the final condition read W₂ = .0078

$$h_2 = 31.7$$

Heat removed = h₂ - h₁ = 31.7 - 58.7 = -27.0 kJ/kg dry air

Moisture removed = W₂ - W₁ = .0078 - .0118 = -.004 kg

To determine the SHR, draw a straight line between the initial and final conditions. Draw a line parallel to this one from the reference point at 24 C DB and 50% RH to the Sensible Heat Factor scale. Read SHR = .64

Problem 6: Evaporative Cooling Refer to Figure 6.

Given: Air at 32 C DB and 18 C WB enters a spray type conditioner and leaves at 90% R.H. Recirculated water to sprays is 18 C.

Find: The leaving DB temperature of the air

Solution: When the spray water temperature is the same as the WB temperature of the entering air, the evaporative cooling process is a constant WB process. Draw a line from the 32 C DB line to the 90% RH line along the 18 C WB line. At its intersection with the 90% RH line read DB = 19.2 C.

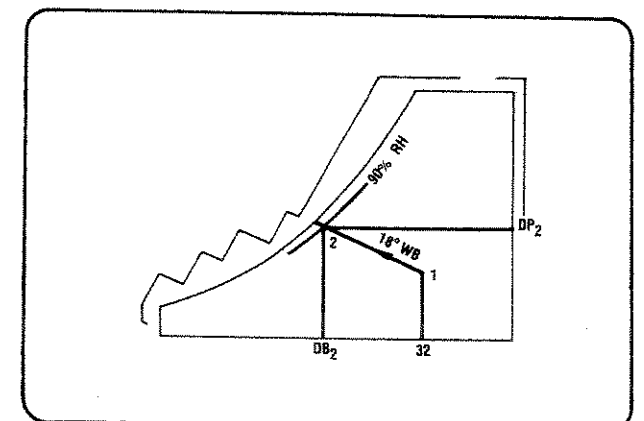


FIGURE 6

DIRECTIONS FOR USING THE TRANE PSYCHROMETRIC CHART

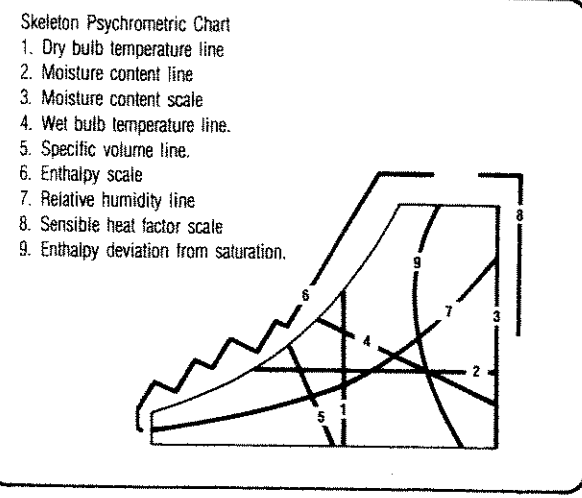


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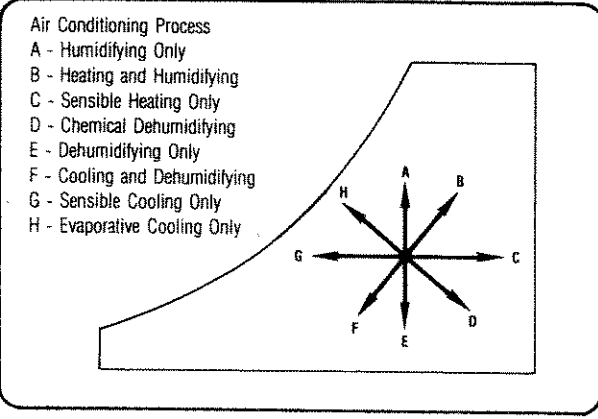


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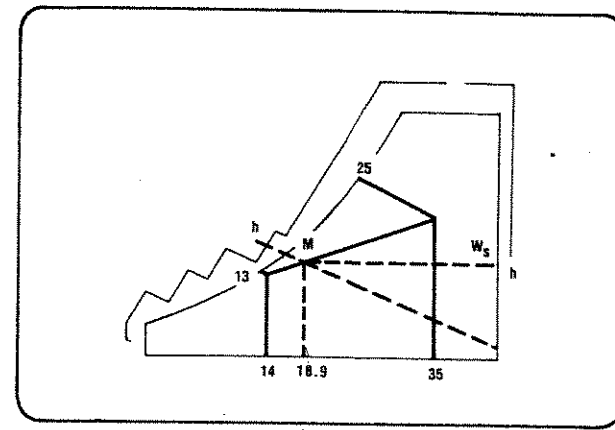


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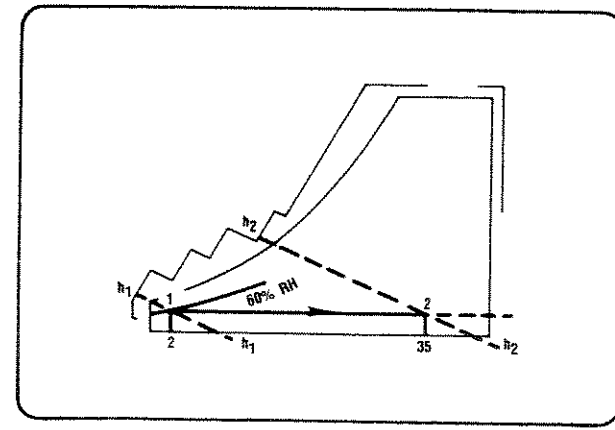


FIGURE 4

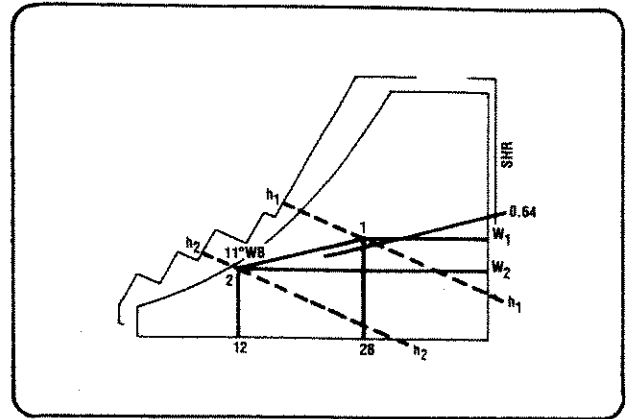


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- Solution: Locate the initial and final conditions on the chart.
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- For the final condition read W₂ = .0078
h₂ = 31.7
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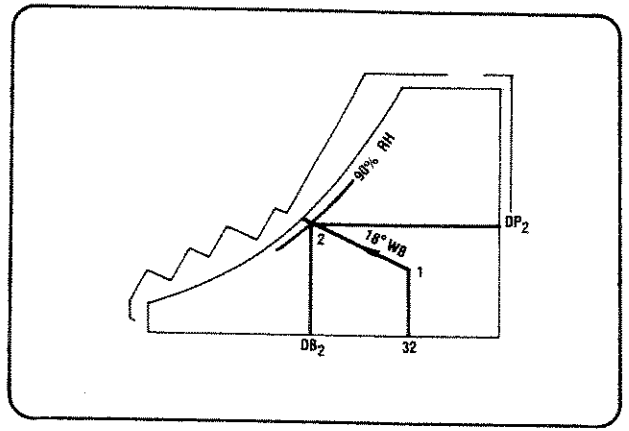


FIGURE 6