Refrigeration and Air conditioning(BTME-4702)

Course Name: RAC

Semester: 7th

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Psychrometry

1) Dry air: The atmospheric air which no water vapour is called dry air.
2) Psychrometry: Psychrometry is the study of the properties of atmospheric air.
3) Temperature: The degree of hotness (or) Coldness is called the temperature.
4) Moisture: Moisture is the water vapour present in the air.
   Humidity: mass of water vapor present in 1kg of dry air
   Absolute humidity: mass of water vapor present in 1cu.m of dry air
5) Relative humidity: Relative humidity is the ratio of actual mass of water vapour in a given volume to the mass of water vapour actually can withhold by the same volume.
6) Dry bulb temperature: The temperature of air measured by the ordinary thermometer is called dry bulb temperature:
7) Wet bulb Temperature: The temperature of air measured by the thermometer when it is covered by the wet cloth is known as wet bulb Temperature.
8) Dew point Temperature: The temperature at which the water vapour starts condensing is called dew point Temperature
9) Wet bulb depression: (DBT- WBT) indicates relative humidity
10) Dew point depression: (DBT- DPT)

Dalton's Law of Partial Pressure

- Dalton's law of partial pressure statures that 'the total pressure of mixture of gases equal to the sum of the partial pressures exerted by each gas when it occupies the mixture volume at there temperature of mixture'.

- According to Dalton's law of partial pressure,
- $Pt = Pa + Pb + Pc.$

Psychrometric Processes

- The process of changing and affecting the psychometric properties of the moist air are called psychometric processes.
- The processes are :

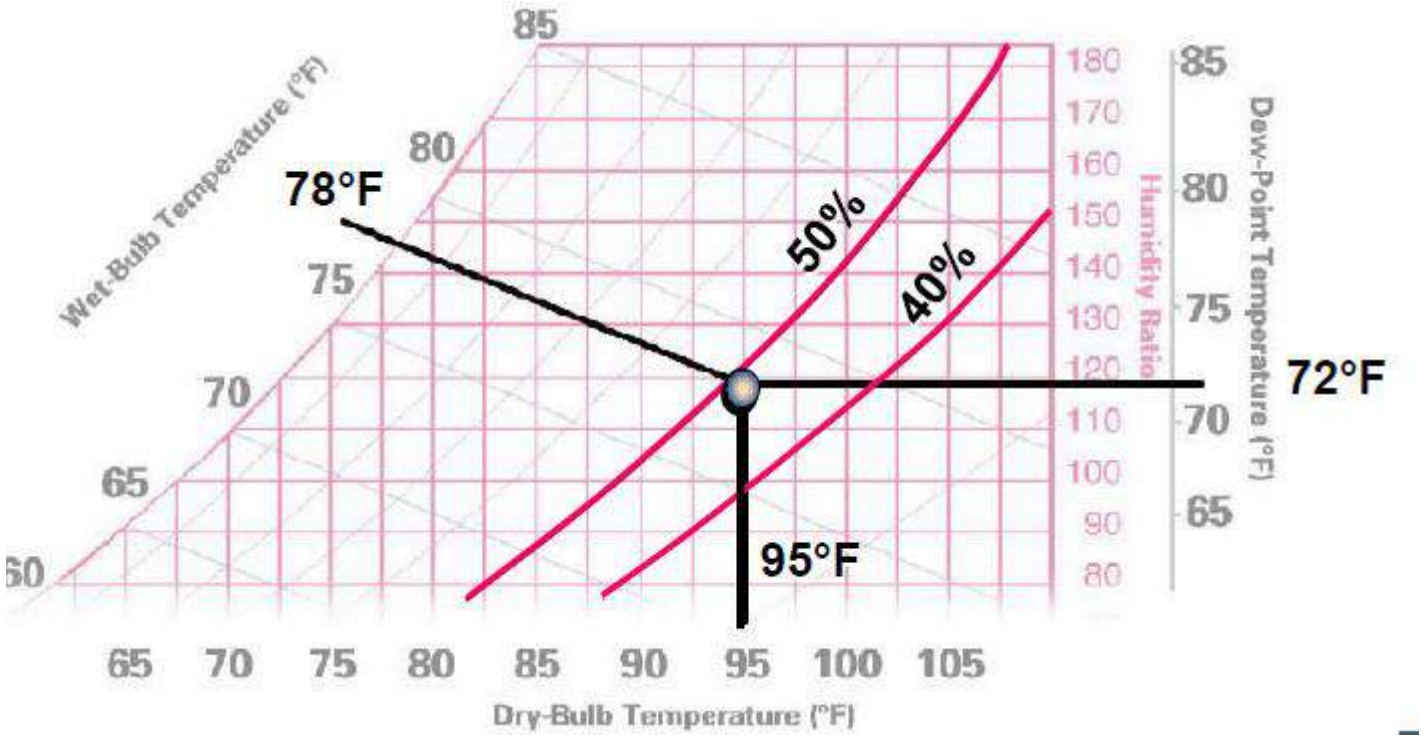
1. Sensible heating 2. Sensible cooling
3. Humidification 4. Dehumidification
5. Heating and humidification
6. Heating and dehumidification
7. Cooling and dehumidification
8. Cooling with adiabatic humidification.
9. Adiabatic mixing of two air streams.

Psychrometric Properties of air

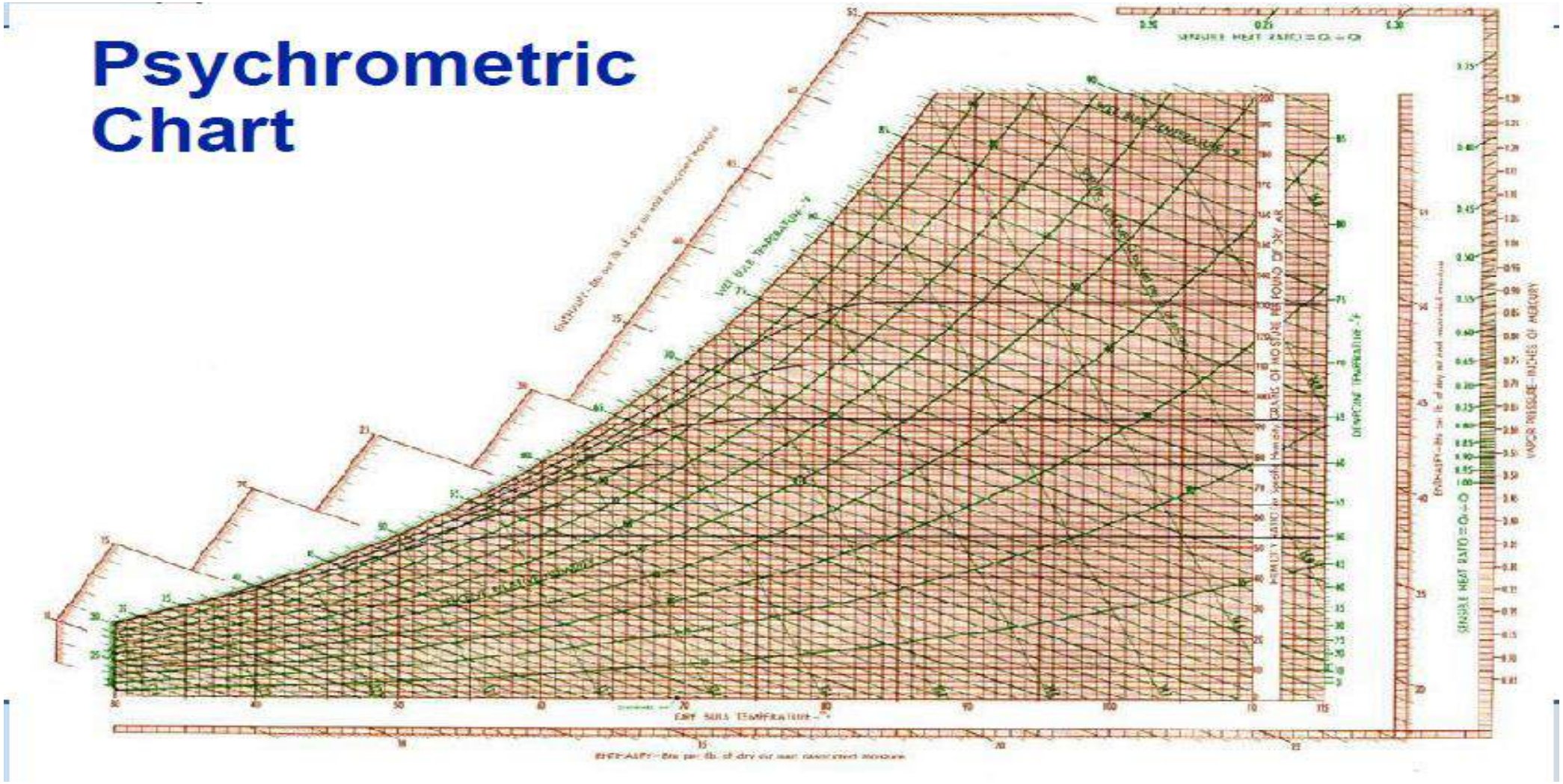
- Dry-bulb temperature
- Wet-bulb temperature
- Dew-point temperature
- Relative humidity
- Humidity ratio

$$\text{Relative Humidity} = \frac{\text{Amount of moisture that a given amount of air is holding}}{\text{Amount of moisture that a given amount of air can hold}}$$

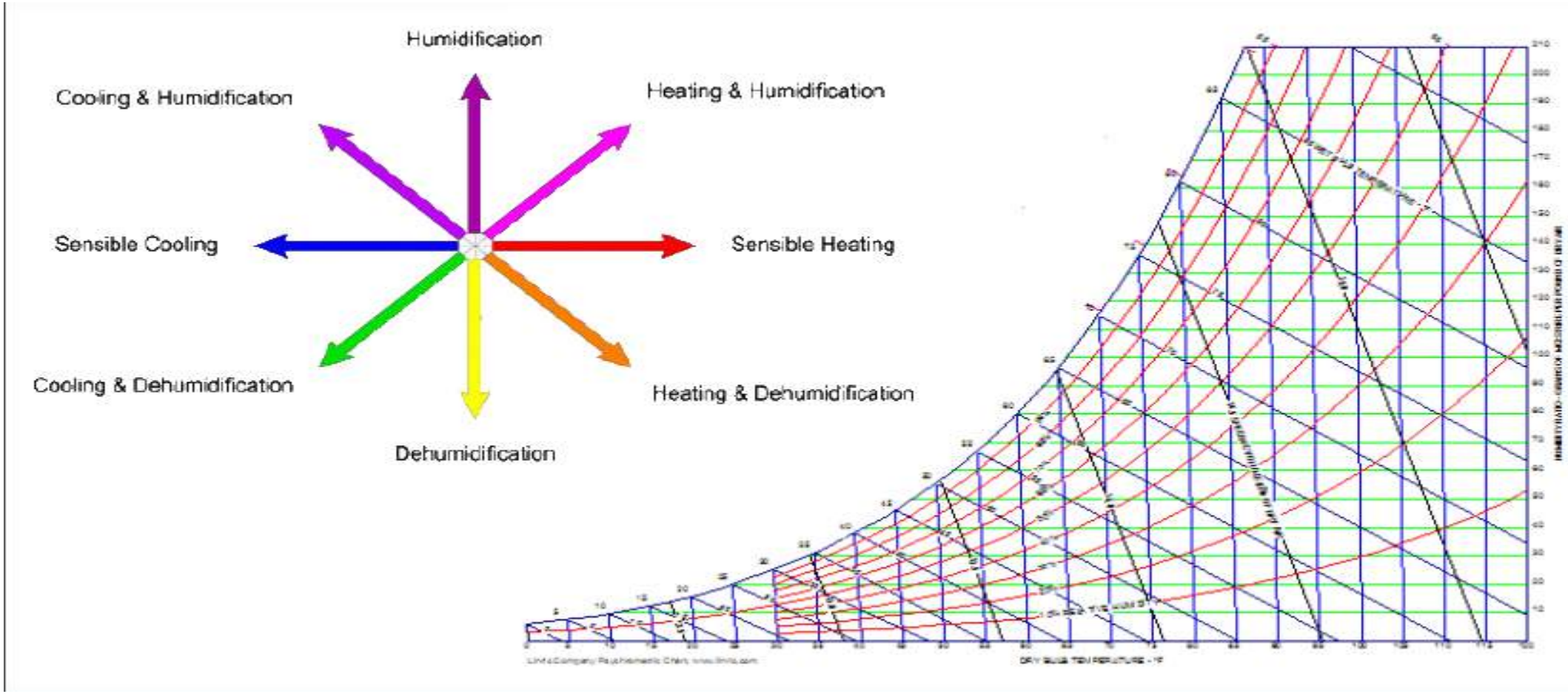
Psychrometry Process



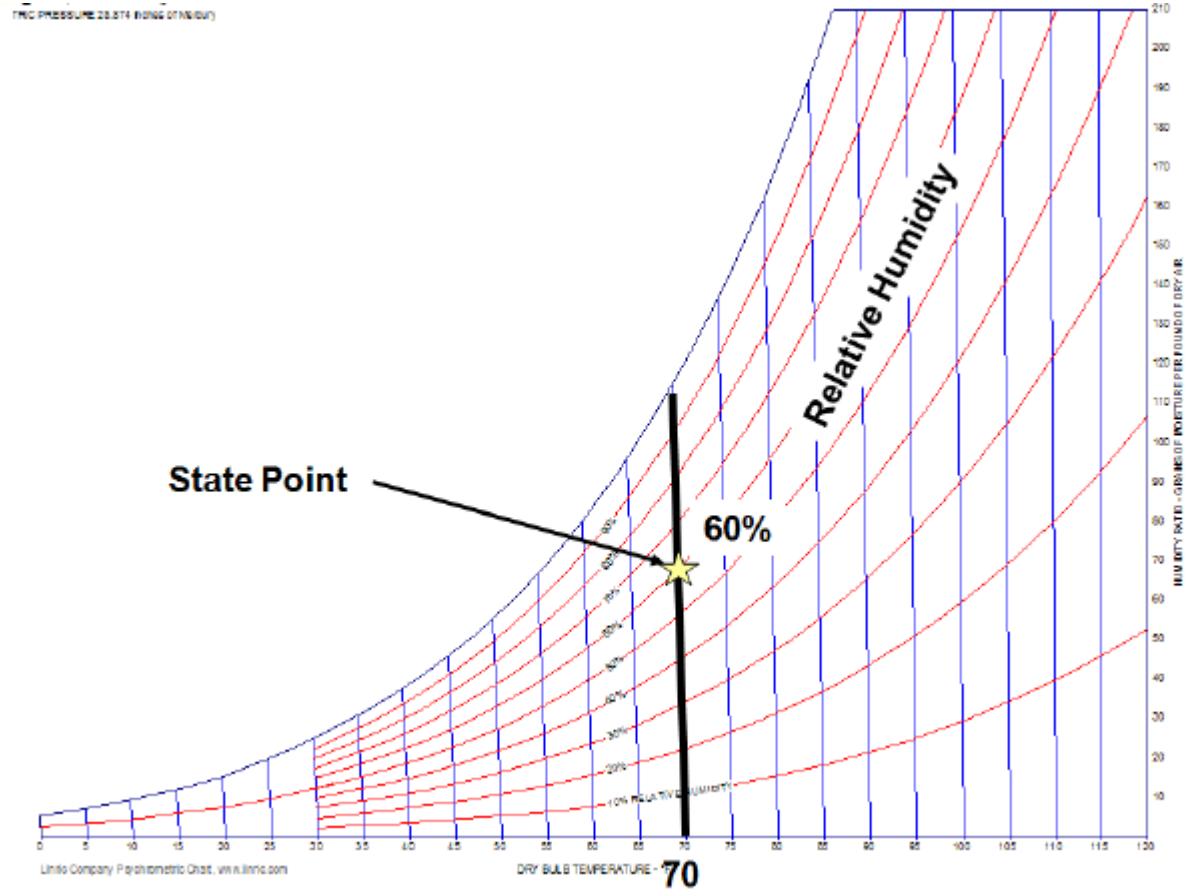
Psychrometric Chart

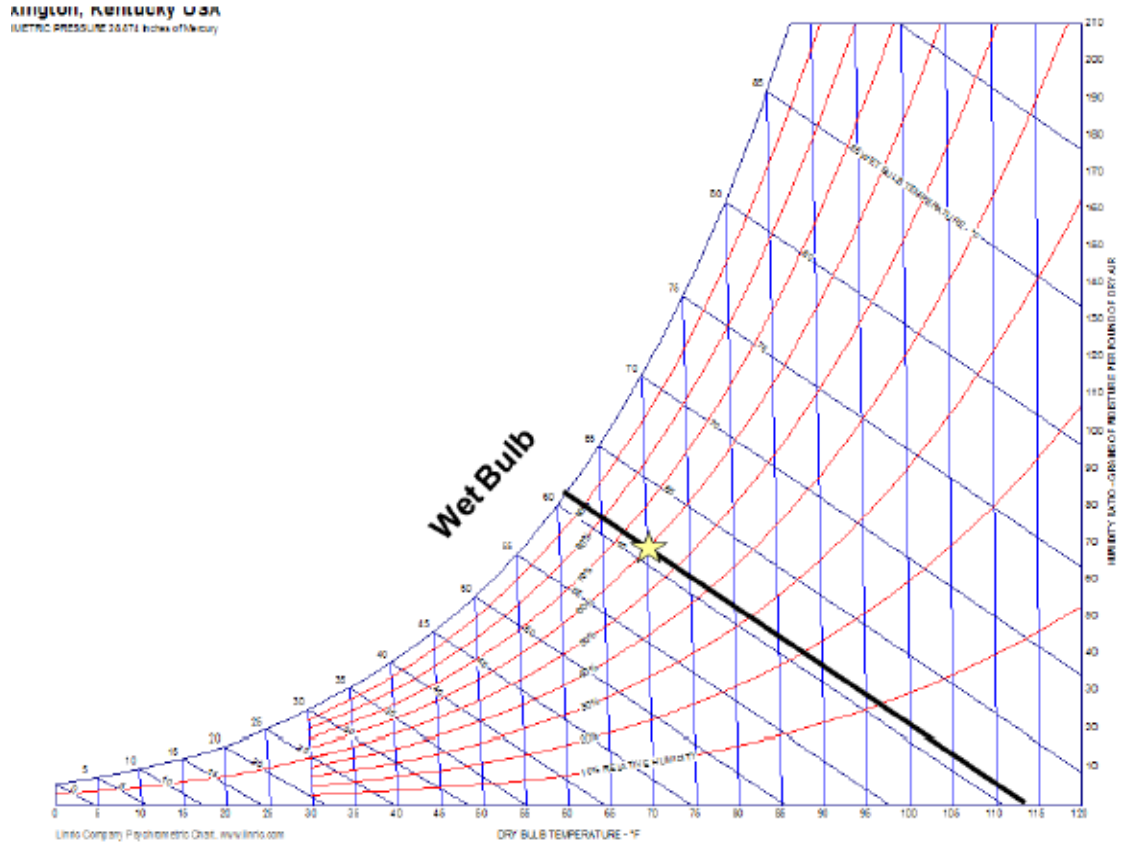


Psychrometry

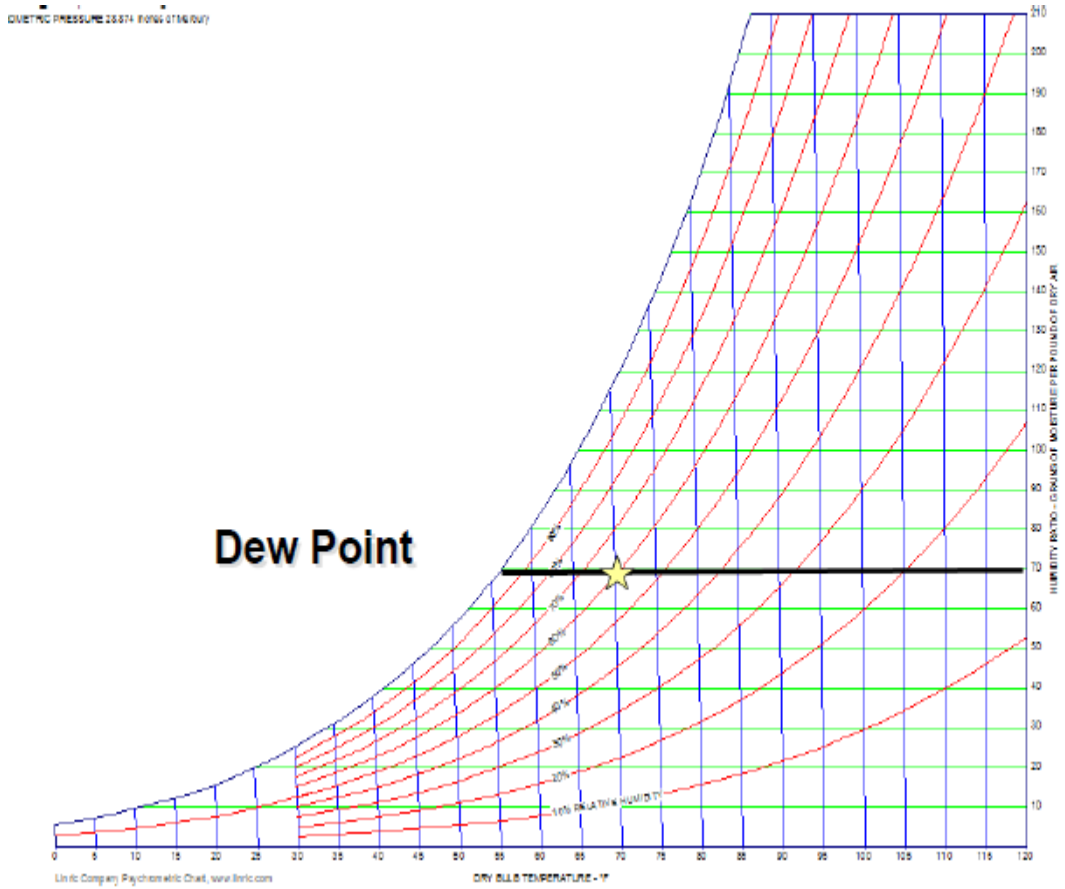


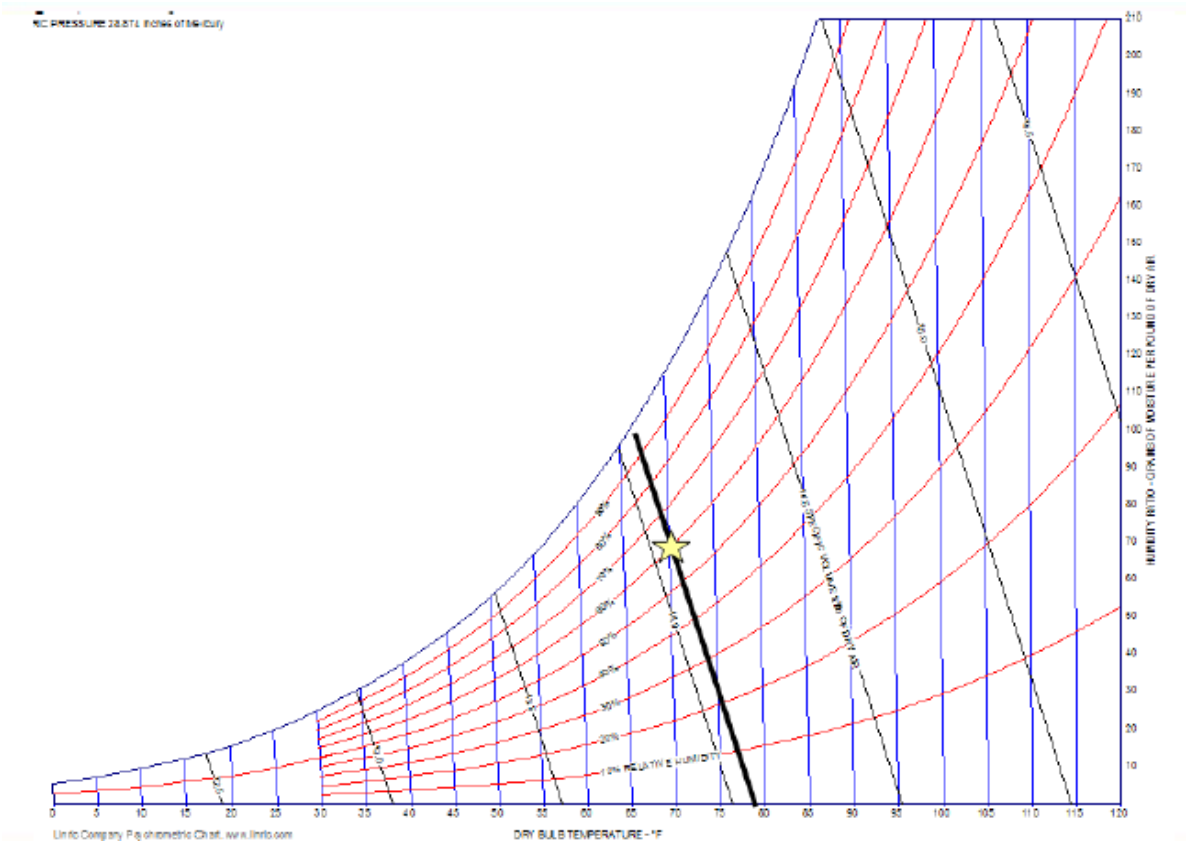
Relative Humidity and WBT in Psychrometric process



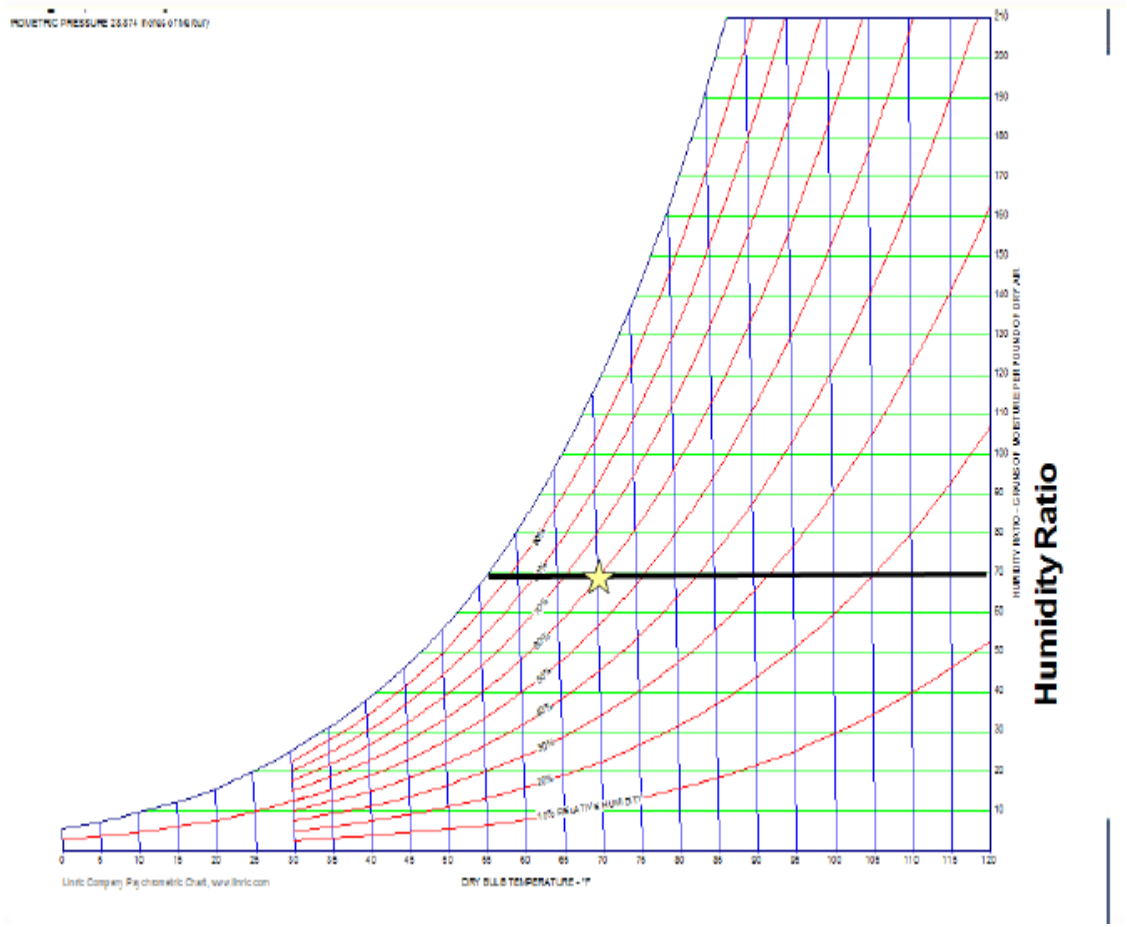


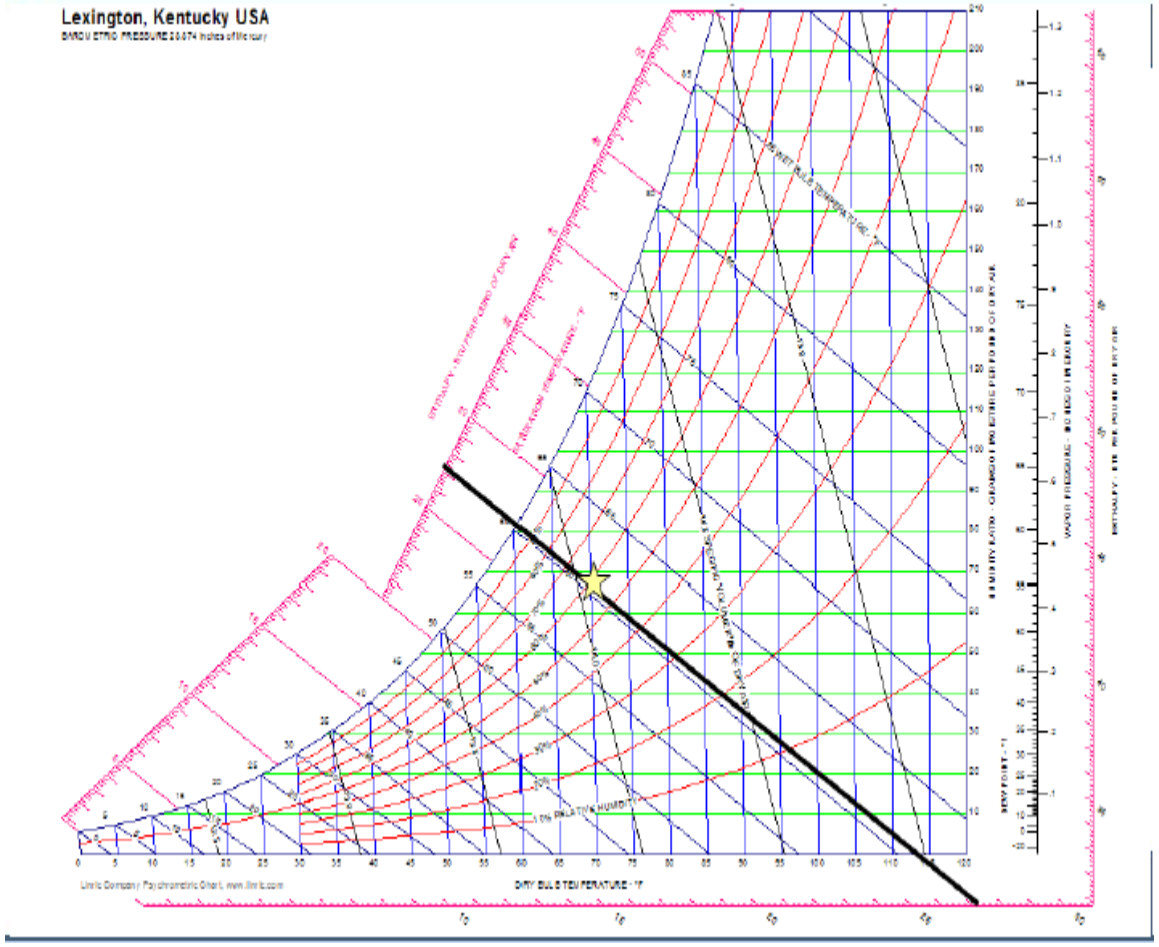
DBT and Specific Volume lines



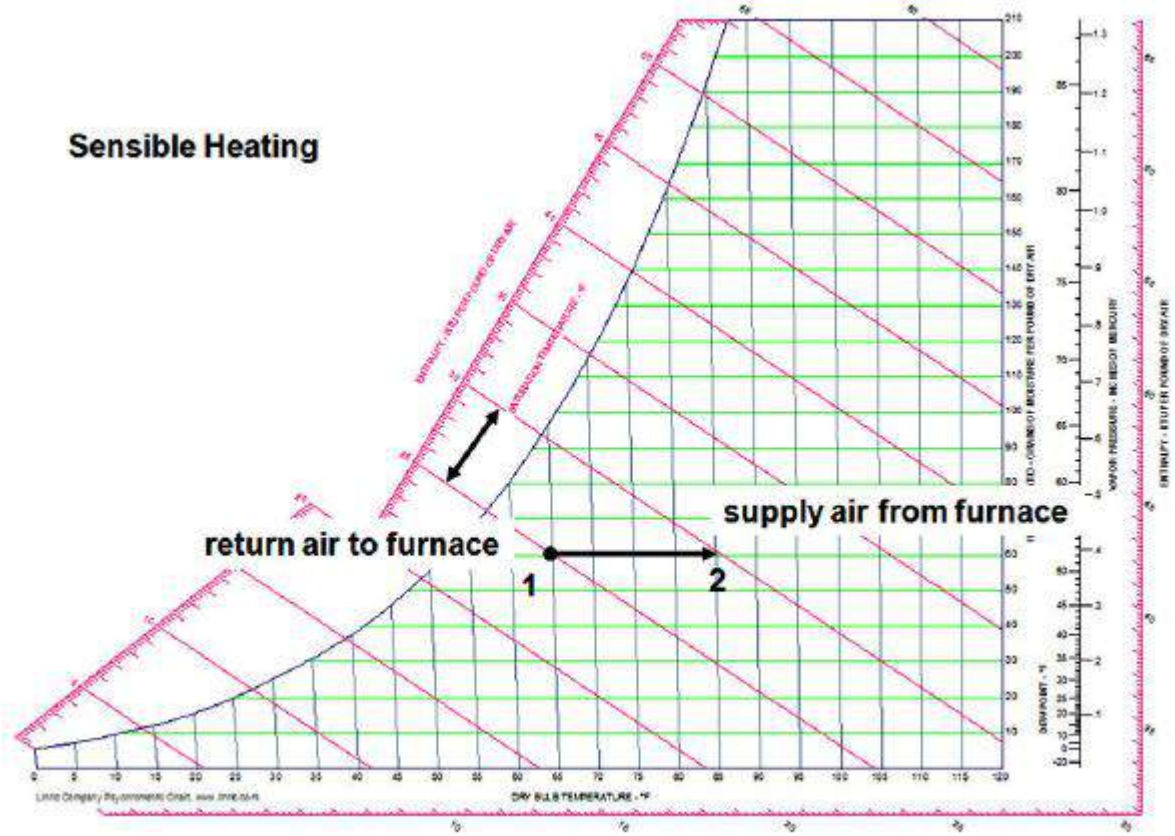


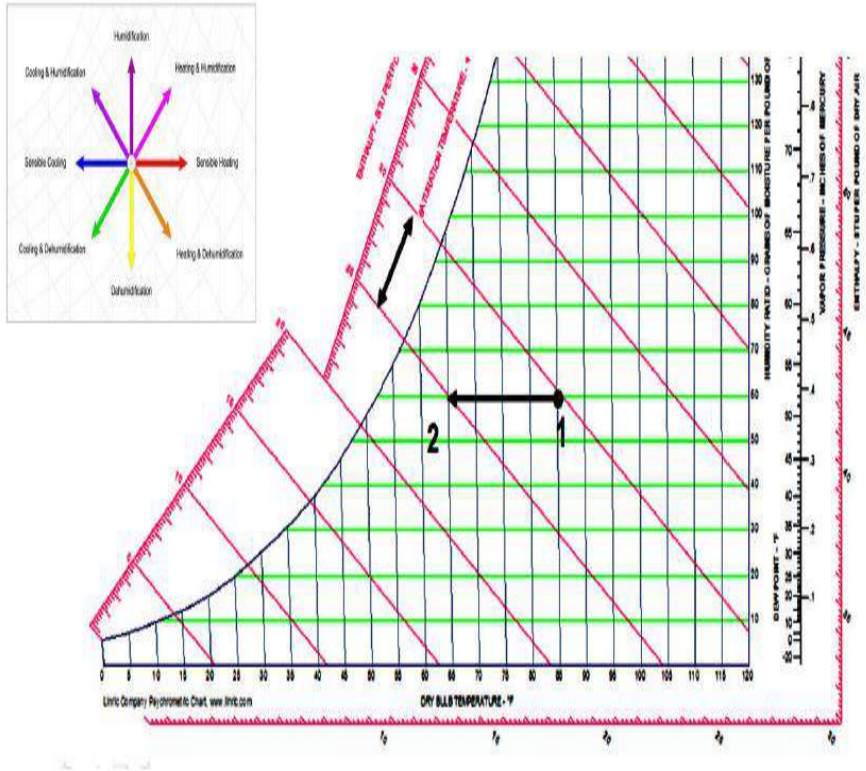
Humidity Ratio and Enthalpy lines



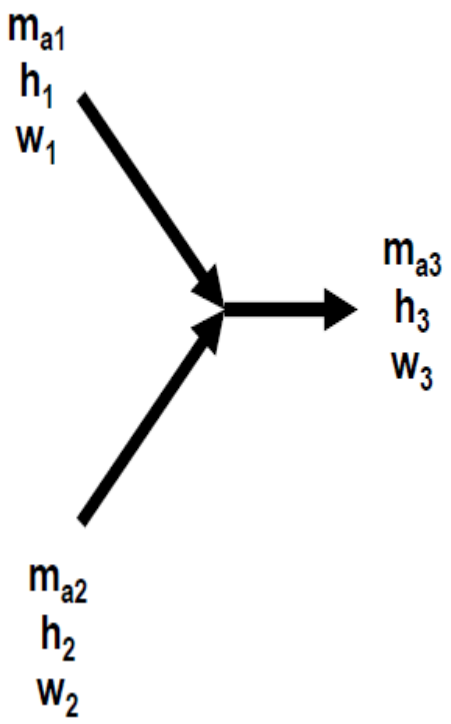


Sensible Heating and Cooling





Mixing of air streams and Cooling systems



Energy Balance

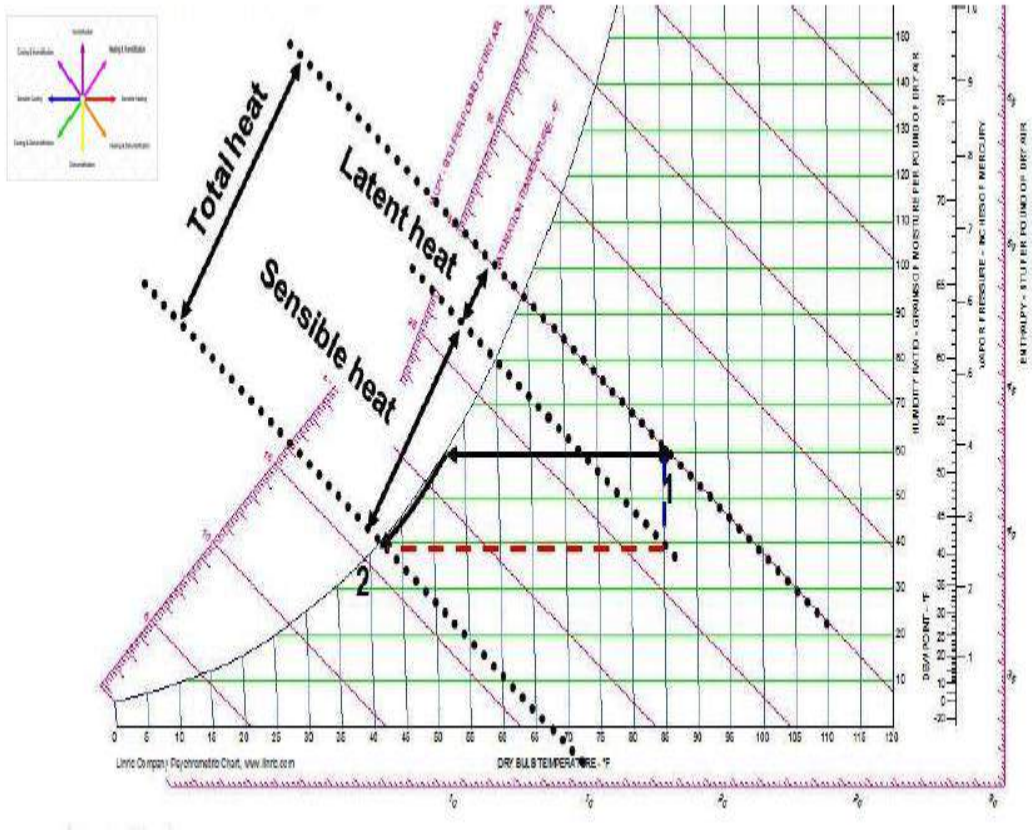
$$m_{a1}\ h_1 + m_{a2}\ h_2 = m_{a3}\ h_3$$

Mass Balance

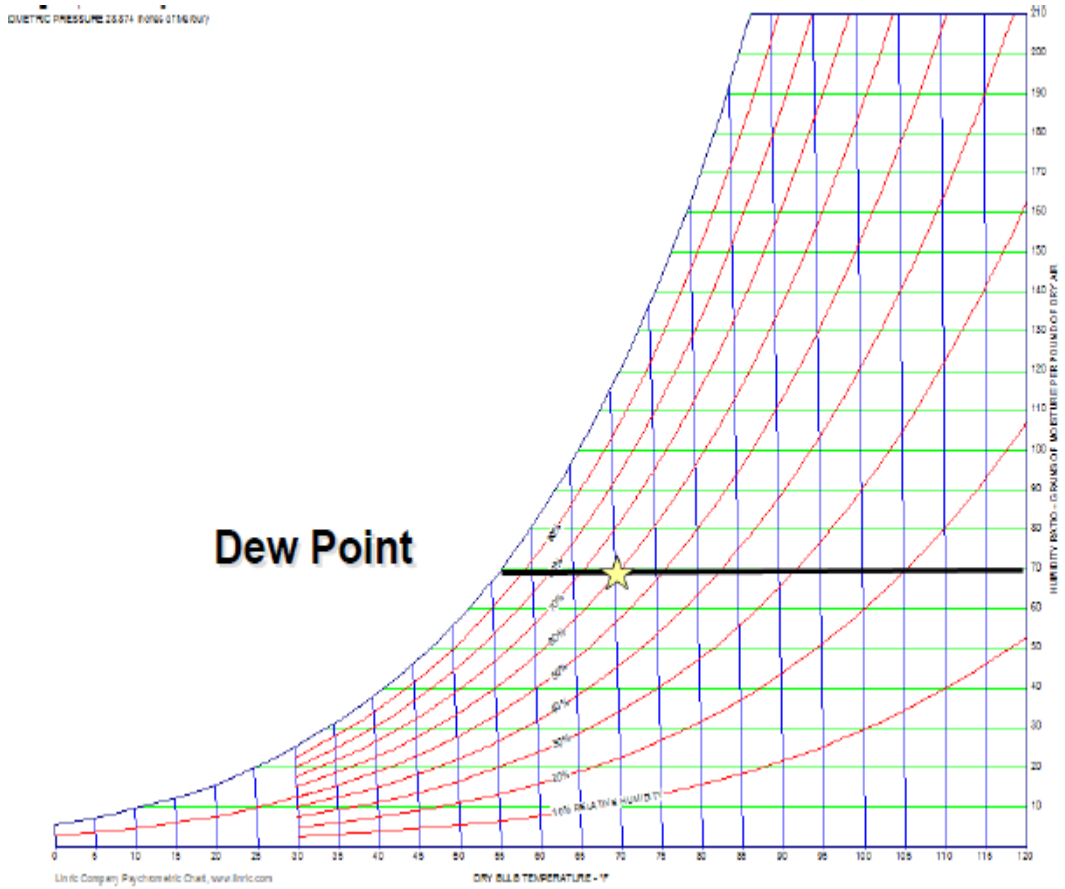
$$m_{a1}\ w_1 + m_{a2}\ w_2 = m_{a3}\ w_3$$

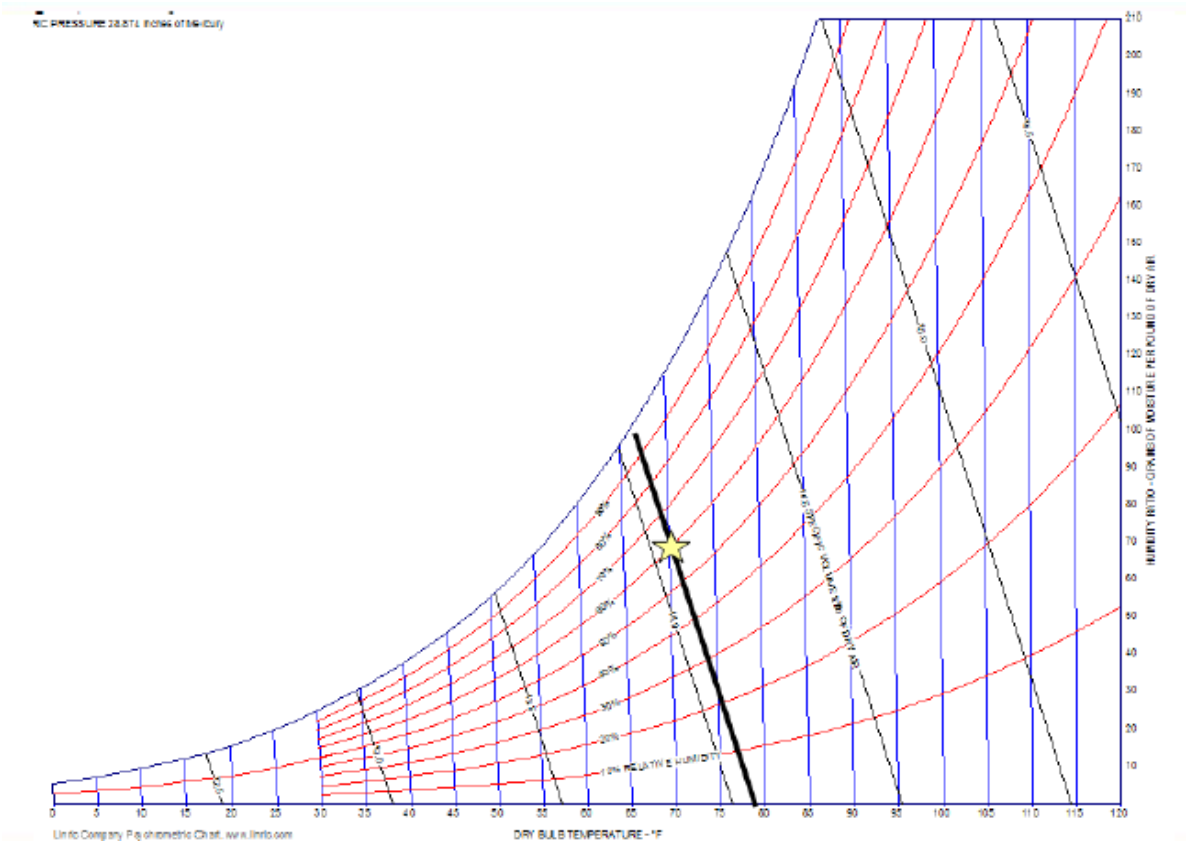
By Algebra

$$\frac{h_2 - h_3}{h_3 - h_1} = \frac{w_2 - w_3}{w_3 - w_1} = \frac{m_{a1}}{m_{a2}}$$



DBT and Specific Volume lines





Air conditioning

- AIR CONDITIONING:
  Air Conditioning is the process of conditioning the air according to the human comfort, irrespective of external conditions.
- Applications of Air Conditioning
  - Used in offices, hotels, buses, cars.,etc
  - Used in industries having tool room machines.
  - Used in textile industries to control moisture.
  - Used in printing press.
  - Used in Food industries, Chemical plants.

CLASSIFICATION OF AIR CONDITIONING

1) According to the purpose
   a) Comfort Air conditioning.
   b) Industrial Air conditioning.
2) According to Season of the year
   a) Summer Air conditioning.
   b) Winter Air conditioning.
   c) Year round Air conditioning

- **Types of Air conditioners**

a) Room Air conditioners
b) Winter Air conditioners
c)Central Air conditioners Functions of Air conditioners
d) Cleaning air.
e) Controlling the temp of air.
f) Controlling the moisture content.
g) Circulating the air.

Window AC

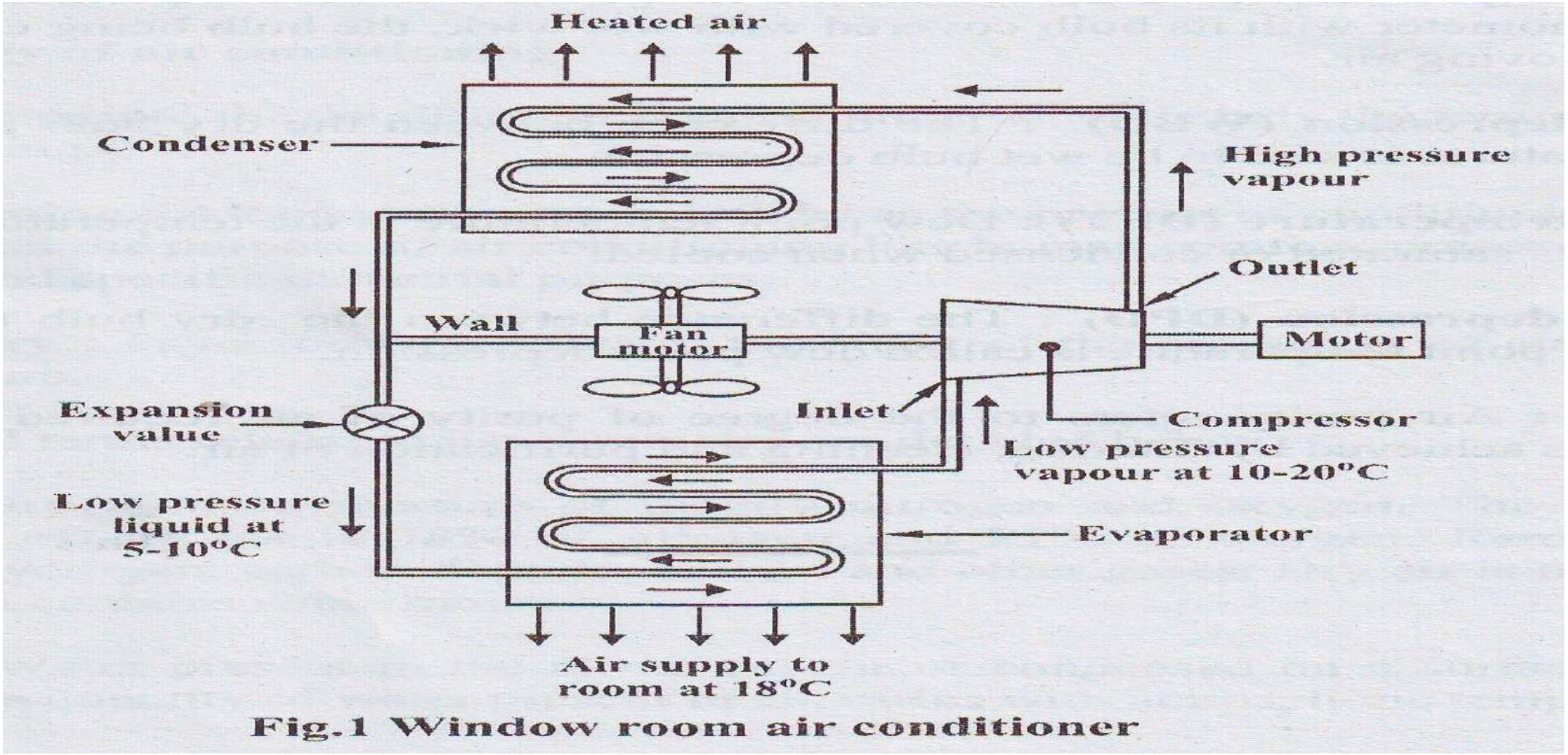
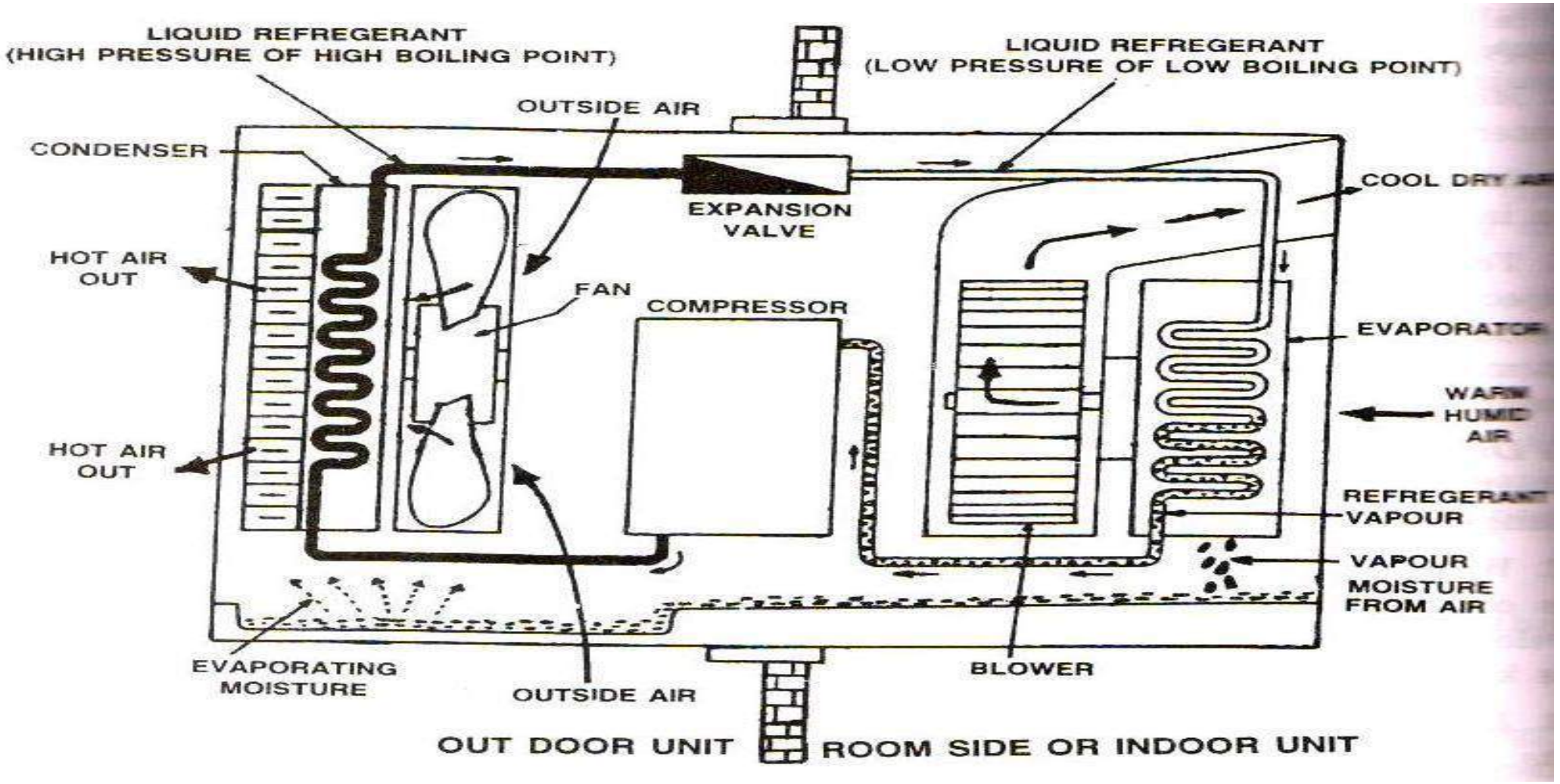


Fig.1 Window room air conditioner

Window AC


LIQUID REFREGERANT
(HIGH PRESSURE OF HIGH BOILING POINT)
OUTSIDE AIR
LIQUID REFREGERANT
(LOW PRESSURE OF LOW BOILING POINT)
CONDENSER
EXPANSION
VALVE
COOL DRY AIR
HOT AIR
OUT
FAN
COMPRESSOR
EVAPORATOR
WARM
HUMID
AIR
HOT AIR
OUT
REFREGERANT
VAPOUR
VAPOUR
MOISTURE
FROM AIR
EVAPORATING
MOISTURE
OUTSIDE AIR
BLOWER
OUT DOOR UNIT
ROOM SIDE OR INDOOR UNIT

Working of Window AC

- The low pressure vapour refrigerant from the evaporator is sucked by compressor through the open inlet valve.
- The compressor compresses the vapour refrigerant.
- The high pressure and high temperature vapour refrigerant then flows to the condenser through the open outlet valve.
- In the condenser, the outside atmospheric temperature in summer being around 42^{o} C, air is circulated by fan.
- After condensation, the high pressure liquid refrigerant formed passes through an expansion valve which reduces its pressure.
- The low pressure refrigerant then enters the evaporator and evaporates, thus absorbing latent heat of vapourisation from the room air.
- The equipment which is used for evaporating the refrigerant is called evaporator.
- After evaporation, the refrigerant becomes vapour.
- The low pressure vapour is again passed to the compressor. Thus the cycle is repeated.
- A partition separates high temperature side of condenser, compressor and low temperature side of evaporator
- The quantity of air circulated can be controlled by the dampers.
- The moisture in the air passing over the evaporator coil is dehumidified and dried into the trays.
- The unit automatically stops when the required temperature is reached in the room. This is accomplished by the thermostat and control panel.
- Generally, the refrigerant monochloro difluro methane ($CHCLF_2$) is used in air conditioner. It is called Freon 22.

Window AC

- **Merits :**
  - A separate temperature control is provided in each room.
  - Ducts are not required for distribution.
  - Cost is less.
  - Skilled technician is required for installation.
- **Demerits:**
  - It makes noise.
  - Large hole is made in the external wall or a large opening to be created in the window panel. This leads to insecurity to inmates.
  - Air quantity cannot be varied.

Split AC

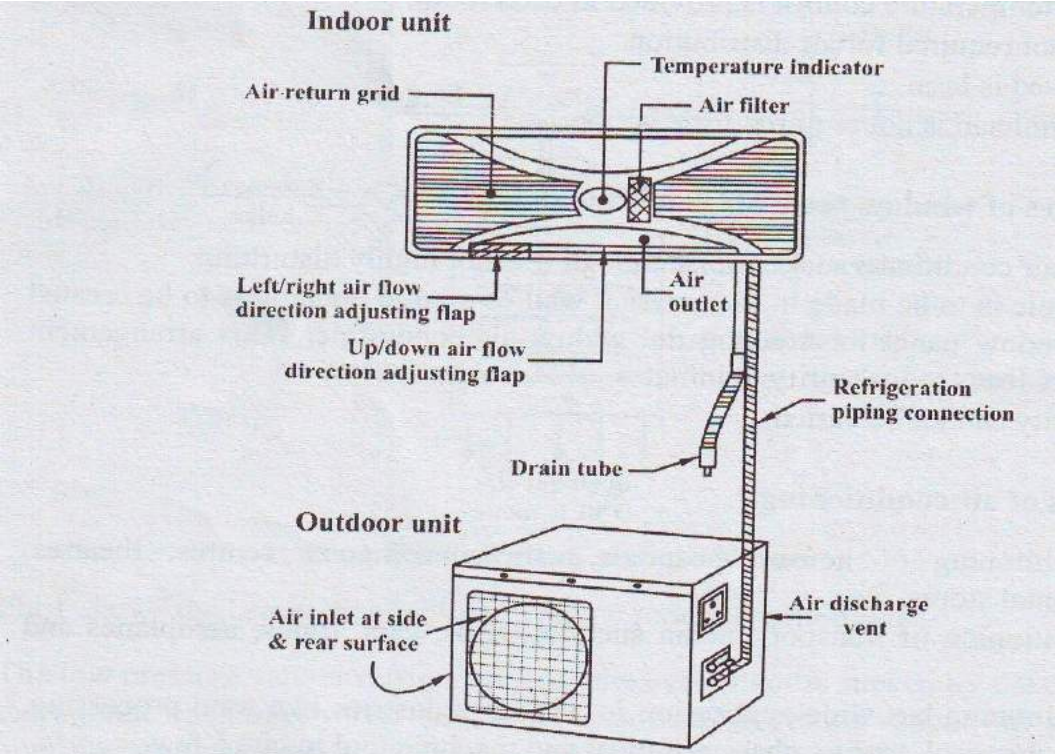
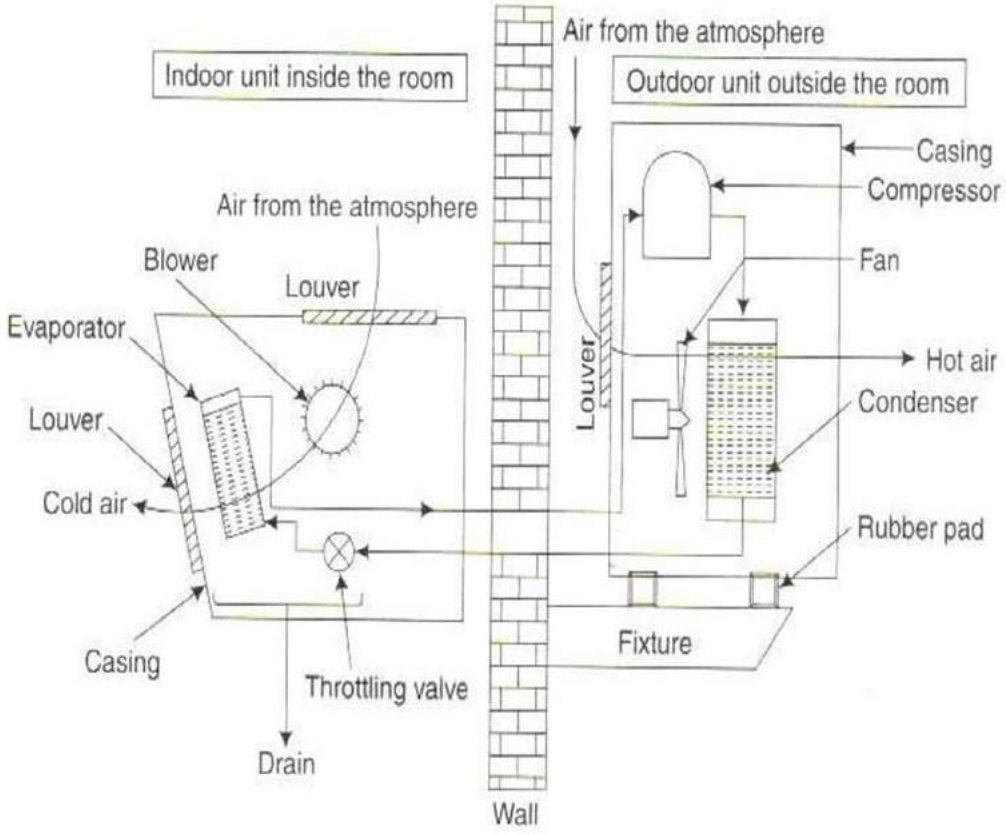


Fig.1 Split type room air conditioner

Fig.1 shows the layout diagram of a split type room air conditioner.



Split AC

- In split air type air conditioner noise making components like compressor and condenser are mounted outside or away from room.
- Split type air conditioning system has two main components.
  (i) Outdoor Unit (ii) Indoor unit.
- The outdoor unit consists of compressor and condenser.
- The indoor unit consists of power cables, refrigerant tube and an evaporator mounted inside the room.
- Compressor is used to compress the refrigerant.
- The refrigerant moves between the evaporator and condenser through the circuit of tubing and fins in the coils.
- The evaporator and condenser are usually made of coil of copper tubes and surrounded by aluminum fins.
- The liquid refrigerant coming from the condenser evaporates in the indoor evaporator coil. During this process the heat is removed from the indoor unit air and thus, the room is cooled. Air return grid takes in the indoor air. Water is dehumidified out of air is drained through the drain pipe.

Split AC

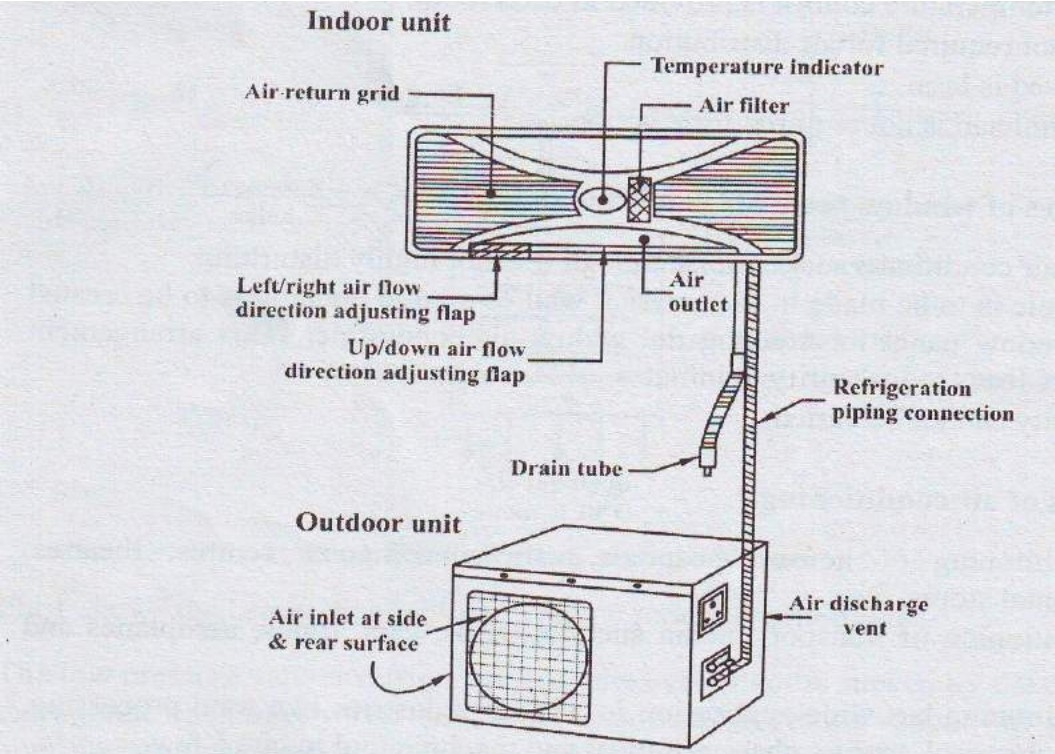
- The hot refrigerant vapour is passed to the compressor and then to the condenser where it becomes liquid.
- Thus the cycle is repeated.
- A thermostat is used to keep the room at a constant, comfortable temperature avoiding the frequent turning on off.

- Merits :
  - It is compact
  - It is energy and money saving.
  - Duct is not used.
  - Easier to install.
  - It is noiseless, because rotary air compressor used is, kept outside.
  - It is more efficient and powerful.
  - It has the flexibility for zoning.
- DeMerits :
  - Initial cost is higher than window air conditioner
  - Skilled technician is required for installation.
  - Each zone or room requires thermostat to control the air cooling.

Applications of Split AC

- Used in houses, hospitals, offices, computer centres, theatres, departmental stores etc.,
- Air-conditioning of transport media such as buses, cars trains, aeroplanes and ships.
- Wide application in food processing, printing, chemical, pharmaceutical and machine tool, etc.,

Split AC



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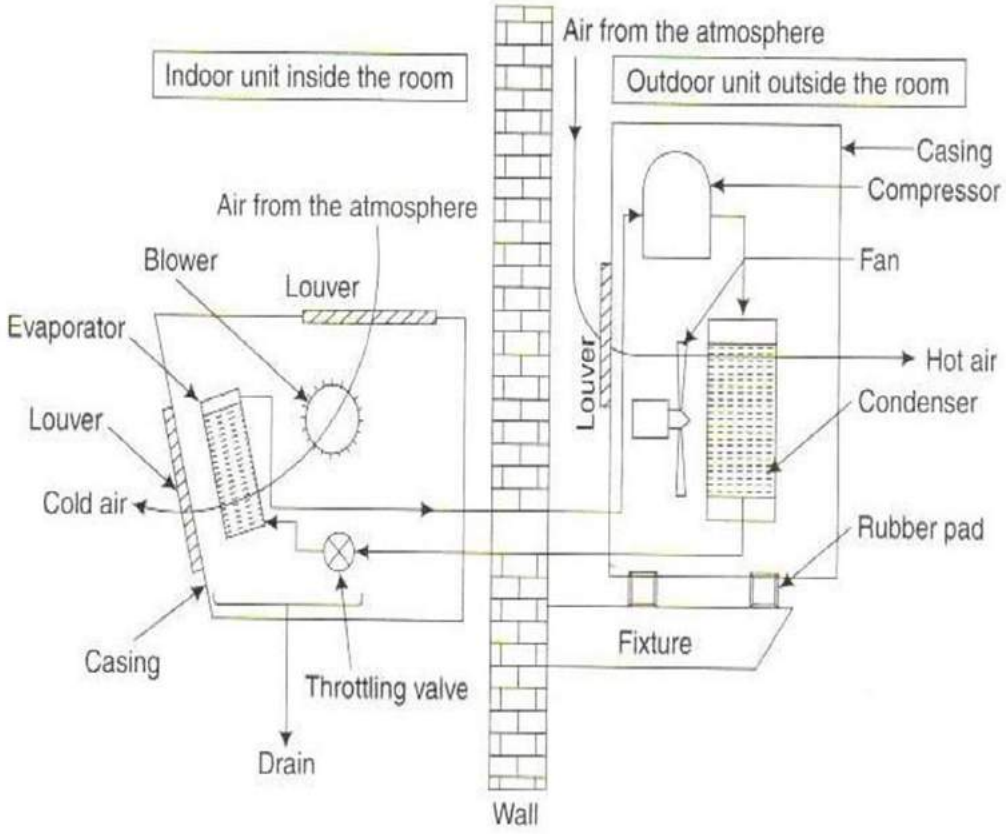
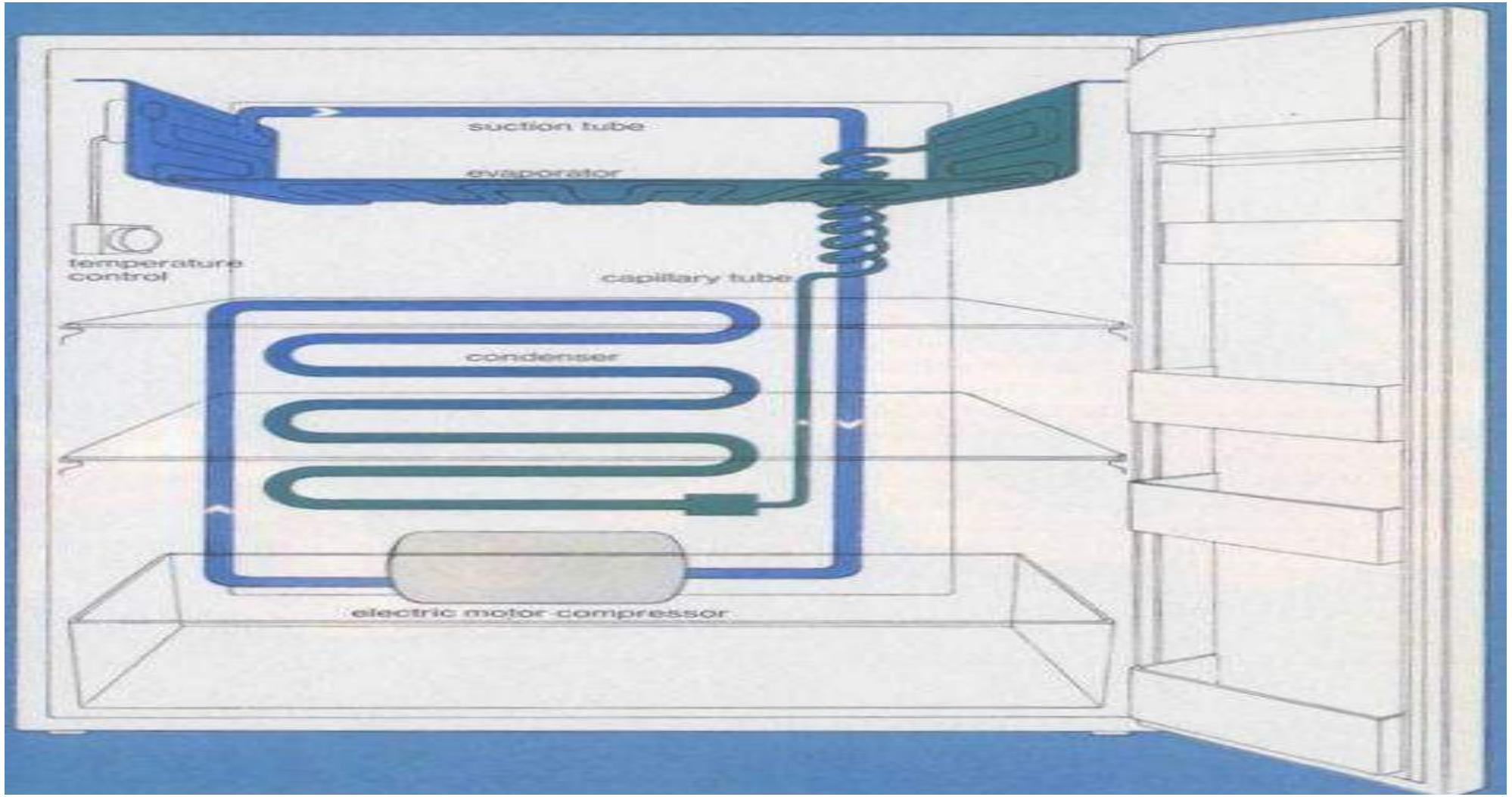
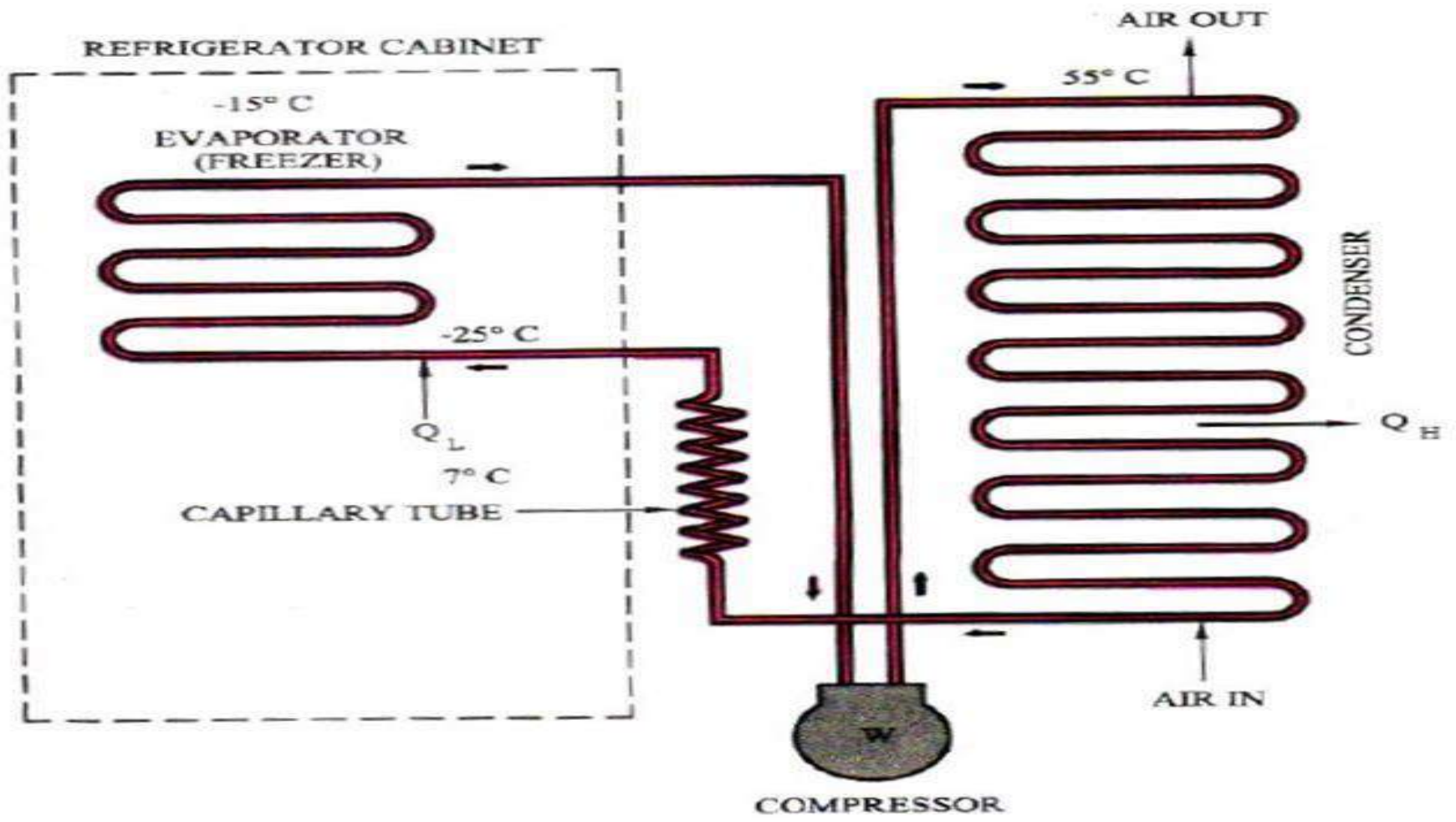


Domestic Refrigerator



Layout of Domestic Refrigerator



Layout of Domestic Refrigerator

- House hold refrigerators use vapor compression cycle
- Less energy: (90 W to 600 W)
  - Due to small and high efficiency motors and compressors,
  - better insulation materials,
  - large coil surface area,
  - better door seals
- Designed to maintain:
  - Freezer section -18 °C
  - Refrigeration section at 3 °C

- Insulation materials:
- Fiber glass, k= 0.032 W/m °C
- Urethane foam, k= 0.019 W/m °C
- Wall thickness for foam
- For freezer section reduced from 90 to 48 mm
- For refrigeration section reduced from 70 to 40 mm
- Works better up to the environment of 43°C
- Ice maker (2 to 3 kg/day)
- Vapor absorption is more expensive and less efficient

Summary

- In this chapter, the focus is on science of psychometry which deals with the conditioning of air in numerous application which thrusts upon its application in daily lives.
- Different types of air conditioning
- Differentiating window and split air conditioner
- Working of domestic refrigerator