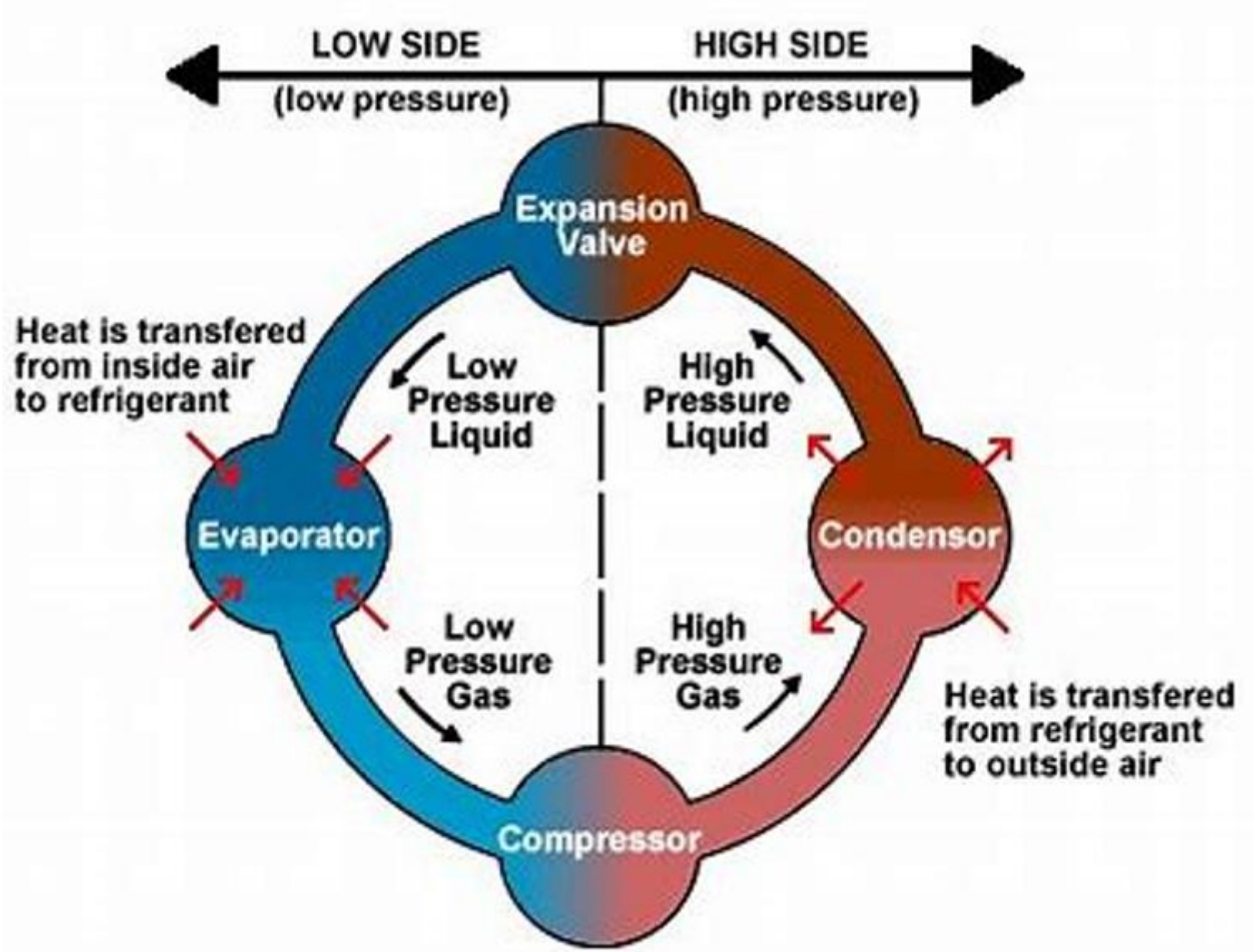
Understanding the Refrigeration Cycle as an HVAC Technician

Presented by: William Smith

TPC

Basic refrigeration cycle

- What are the 4 major components and how air conditioning works
- What is super heat and subcooling and how to use it for system troubleshooting


LOW SIDE
(low pressure)
HIGH SIDE
(high pressure)
Expansion Valve
Heat is transfered from inside air to refrigerant
Low Pressure Liquid
High Pressure Liquid
Evaporator
Condensor
Low Pressure Gas
High Pressure Gas
Heat is transfered from refrigerant to outside air
Compressor

Heat Transfer

Air Conditioning and Refrigeration is the transfer of heat from a place it is not wanted to a place that makes little or no difference.
Taking humidity and heat out is what makes us feel cool. There is no cold but an absence of heat in the air. Cold is a compression of two things

85 deg f is cooler than 100 deg f so 85 is cold

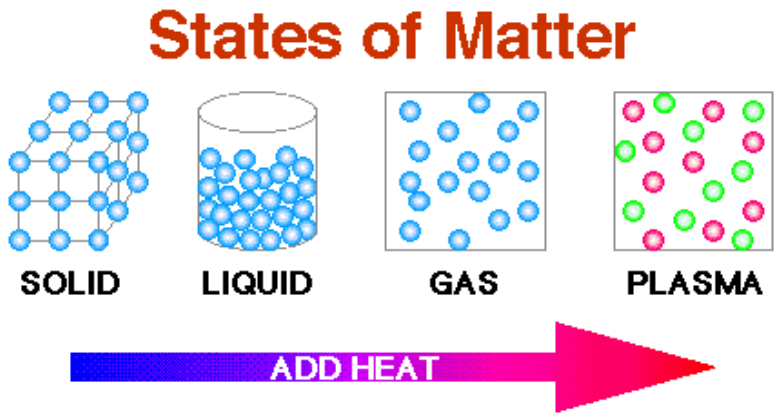
Follow-the-Heat ™

- Conditioned space to refrigerant
- Refrigerant to outside air (if air cooled)
- Refrigerant to condenser water (if water cooled)
- Condenser water to outside air at cooling tower (or spray pond)

Thermodynamics

Matter – anything that occupies space and has weight

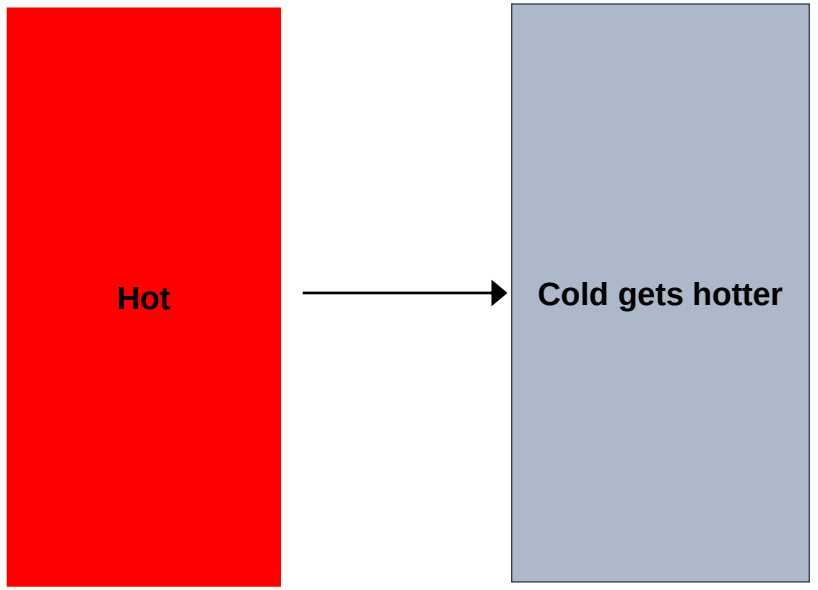
- **Solid** Exerts pressure downward
- **Liquid** Exerts pressure on all sides
- **Gas** Exerts pressure in all directions



Thermodynamics

The Second Law of Thermodynamics

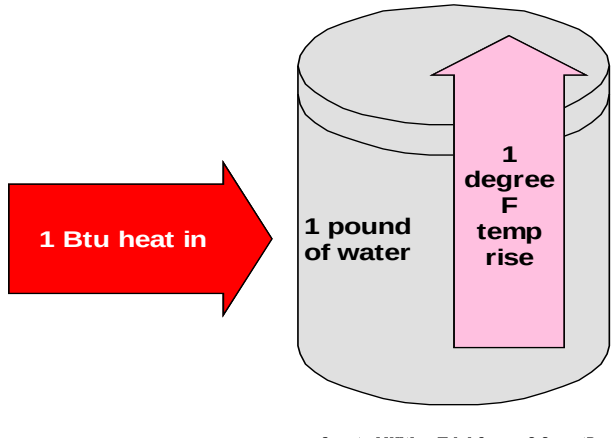
“Heat flows from a warmer place to a cooler place”

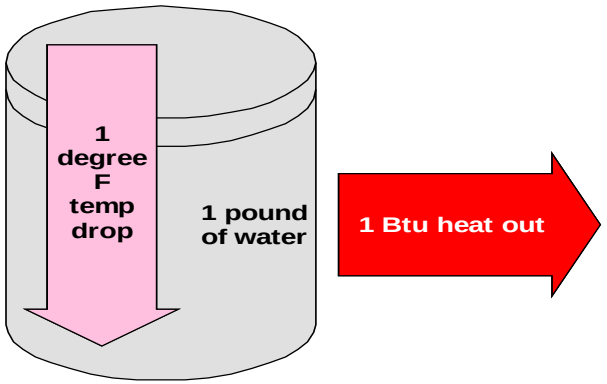


British Thermal Unit

1 Btu is the amount of heat required to raise the temperature of

1 pound of water 1° F



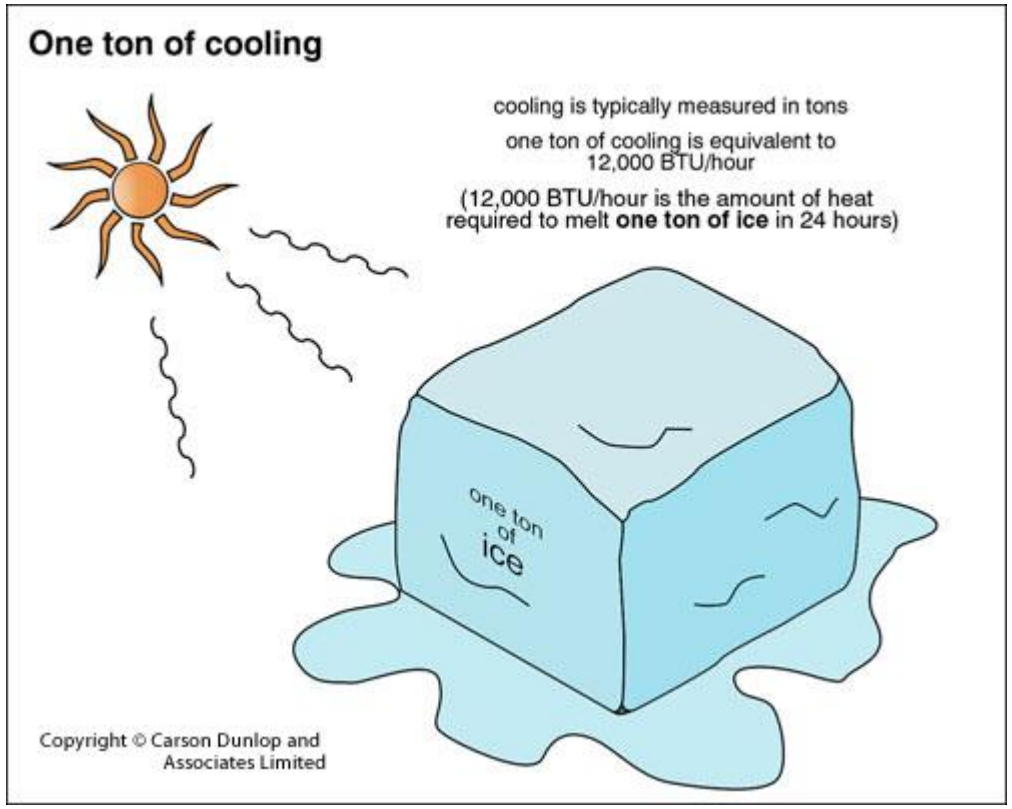


If 1 Btu is removed from 1 pound of water the temperature will decrease by 1° F

Tons of Refrigeration

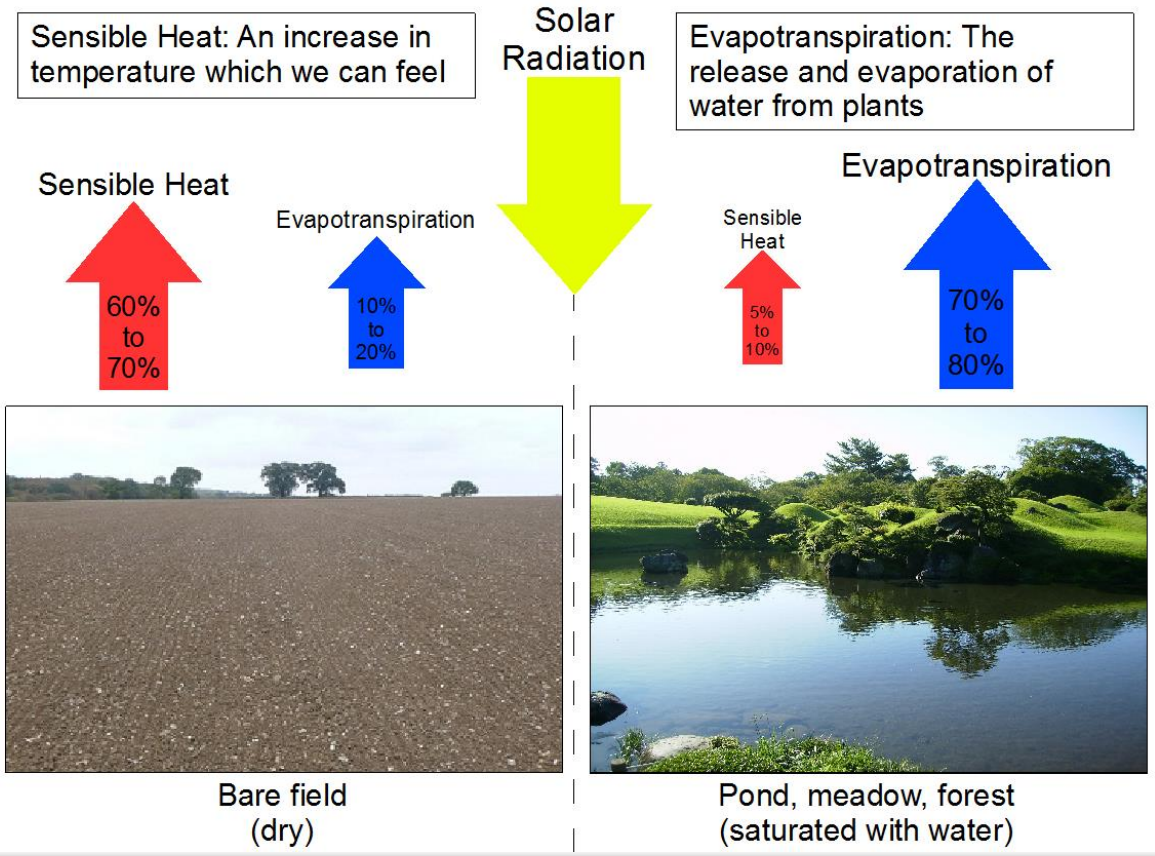
One Ton of Refrigeration:

2000 pounds of 32° F ice requires 288,000 Btu to melt in 24 hours = 12,000 Btu/hour



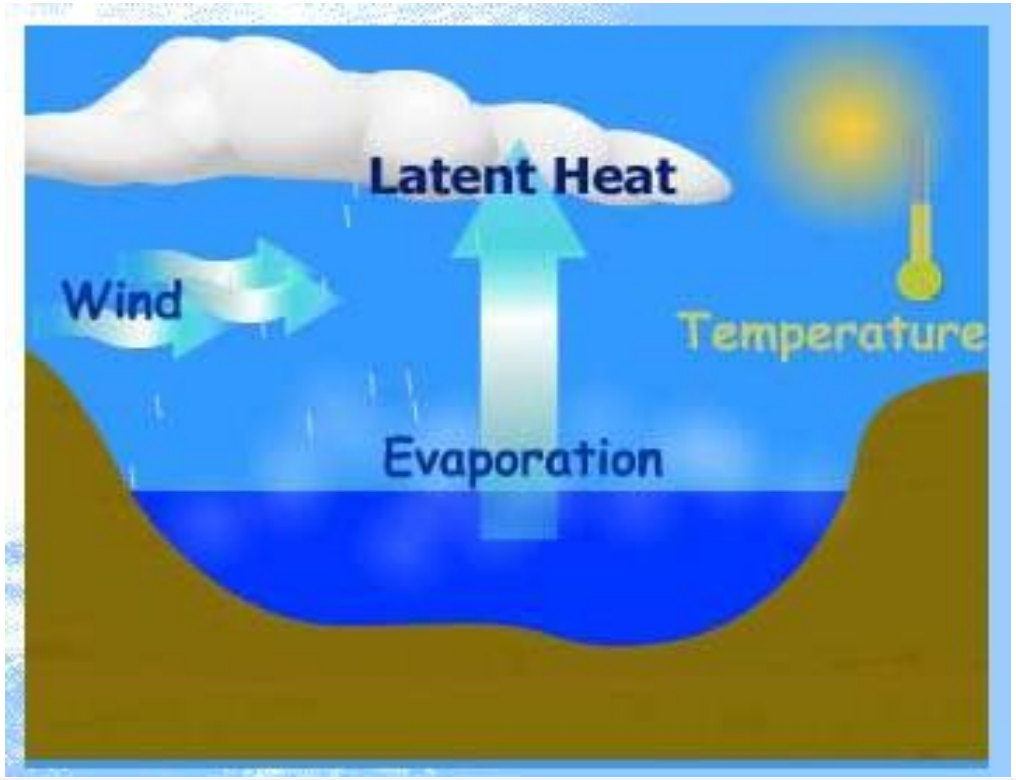
Sensible Heat

Heat added or removed that causes a change in temperature is called sensible heat



Latent Heat

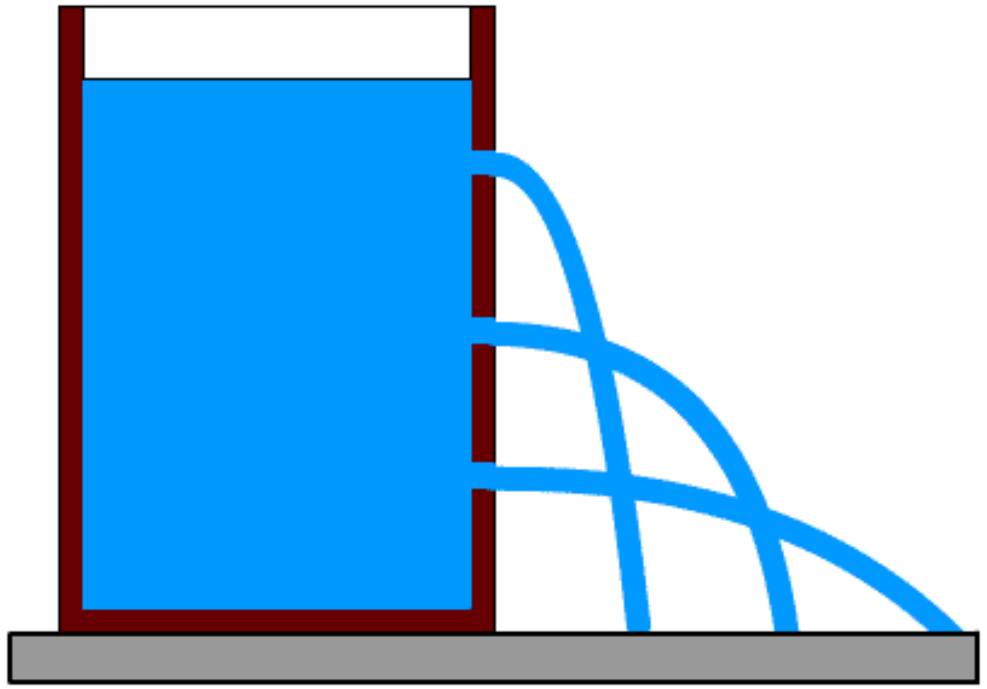
Heat added or removed that causes a change of state is called latent heat



Pressure

Pressure: is defined as force per unit of area

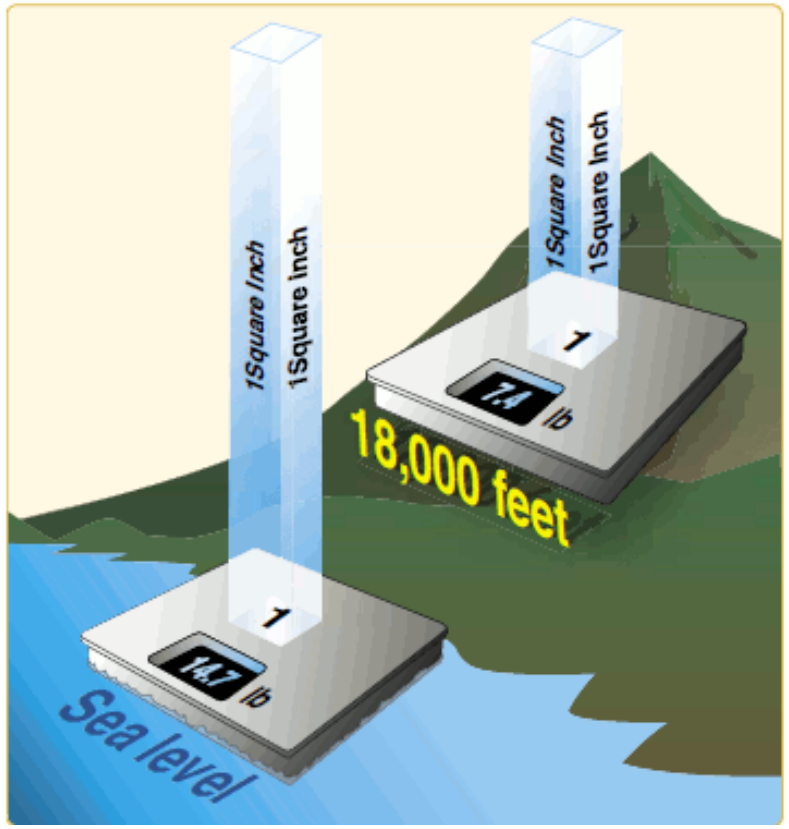
Pound per square inch (psi)



Atmospheric Pressure

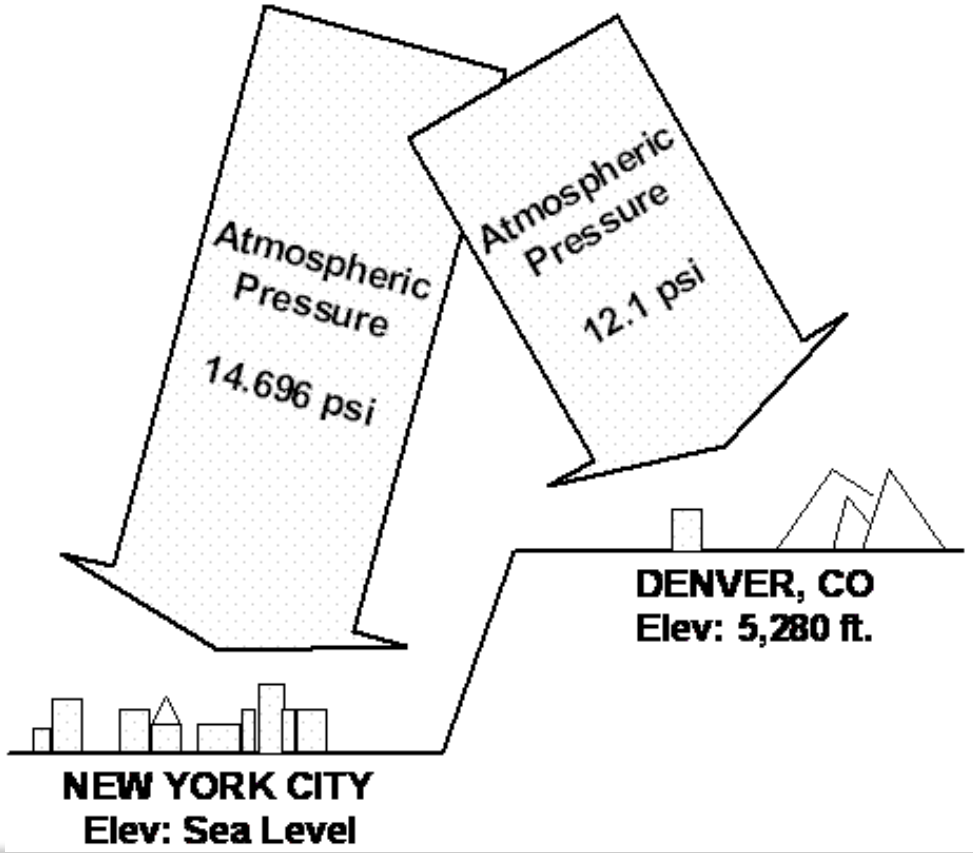
Standard atmospheric pressure is:

14.7 psi at sea level (70˚ F) [1 atm]



Atmospheric Pressure

Atmospheric pressure: decreases at a rate of 0.49 psi per 1000 feet of elevation



Pressure

- psi – pounds per square inch
  Force per unit of area

- psig – pounds per square inch gauge
  Gauge pressure ignores atmosphere

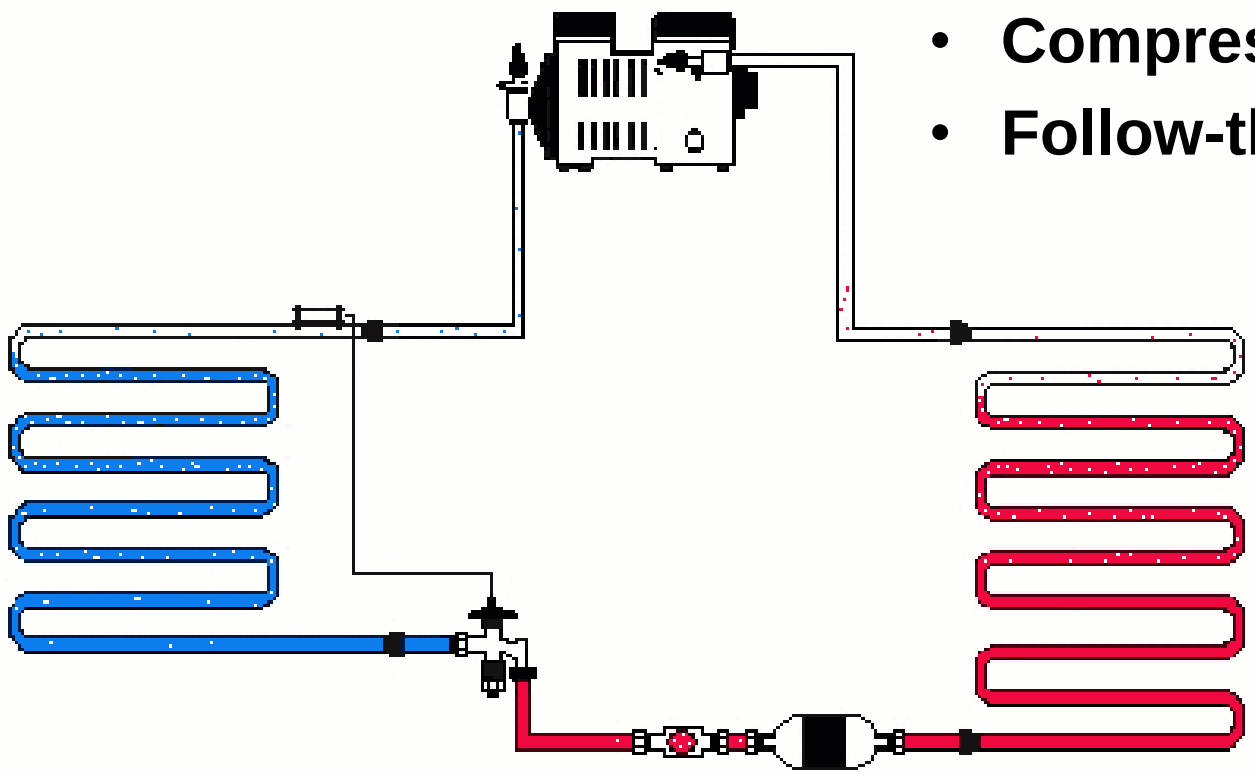
- psia – pounds per square inch absolute
  The sum of gauge pressure plus atmosphere
  Vacuum
  The absence of atmospheric pressure
  Measured in inches of mercury (inhg vac)
  And microns

Pressure - Temperature

- Pressure / vacuum affects the saturation, vaporization, and condensation temperatures
- Pressure increase = saturation (boiling point) increase
- Pressure decrease = saturation (boiling point) decrease

The pressure of a liquid determines its boiling (saturation) temperature

Compression Refrigeration Cycle



- Refrigeration
- Compression Cycle Theory
- Follow-the-Heat ™

Four Major Components

- Evaporator

– to remove the heat from the conditioned space or process

- Compressor

– to pump and pressurize the refrigerant

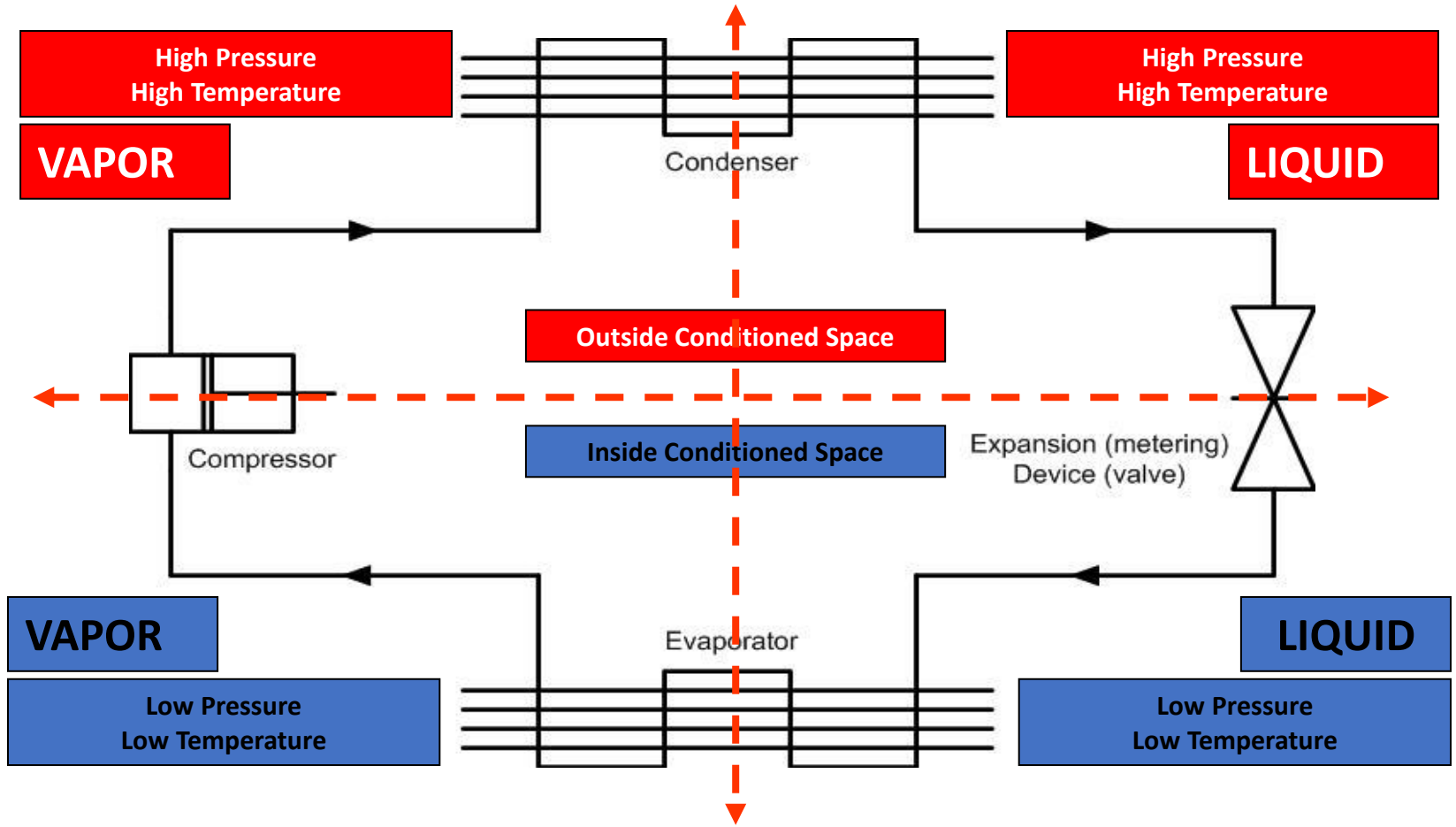
- Metering (expansion) device

– to change high-pressure refrigerant to low- pressure refrigerant

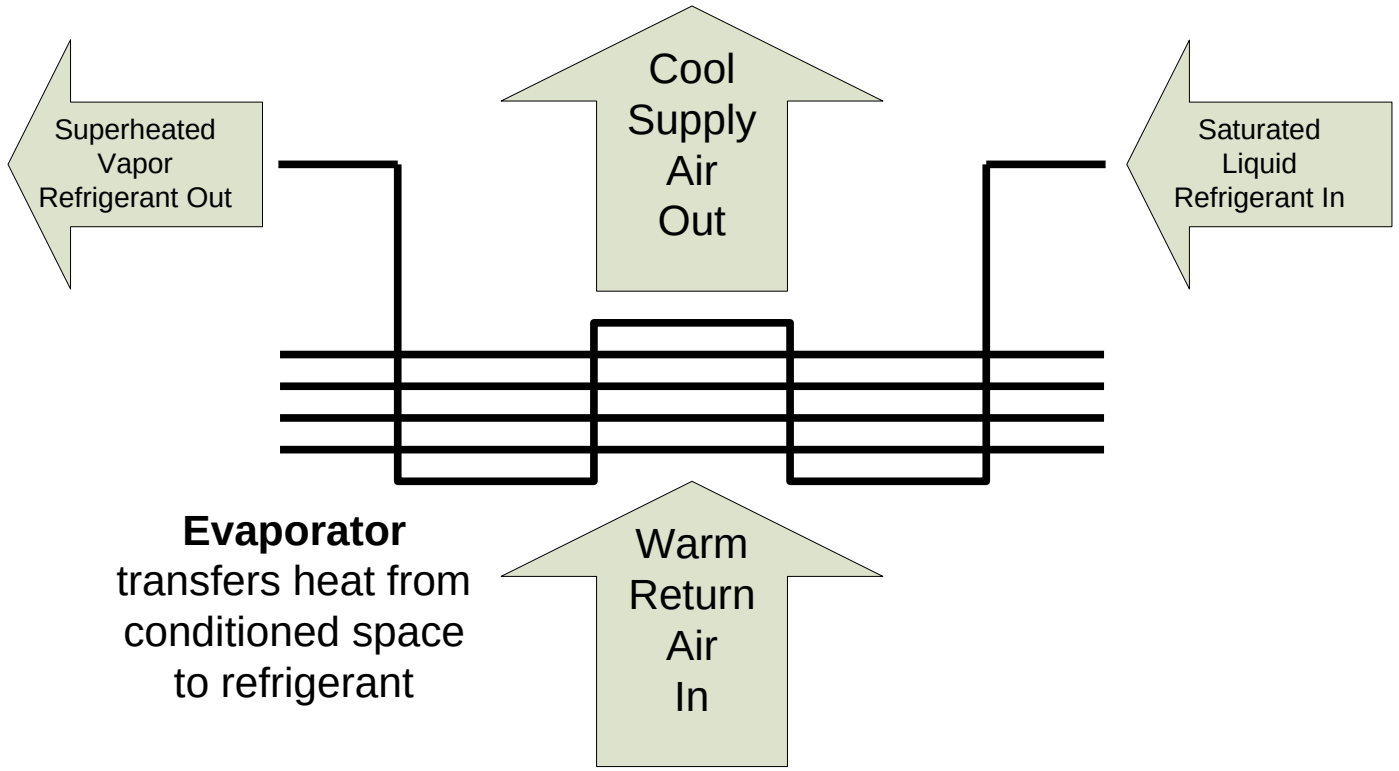
- Condenser

– to remove the heat from the conditioned space or process

Refrigeration Cycle



Follow-the-Heat

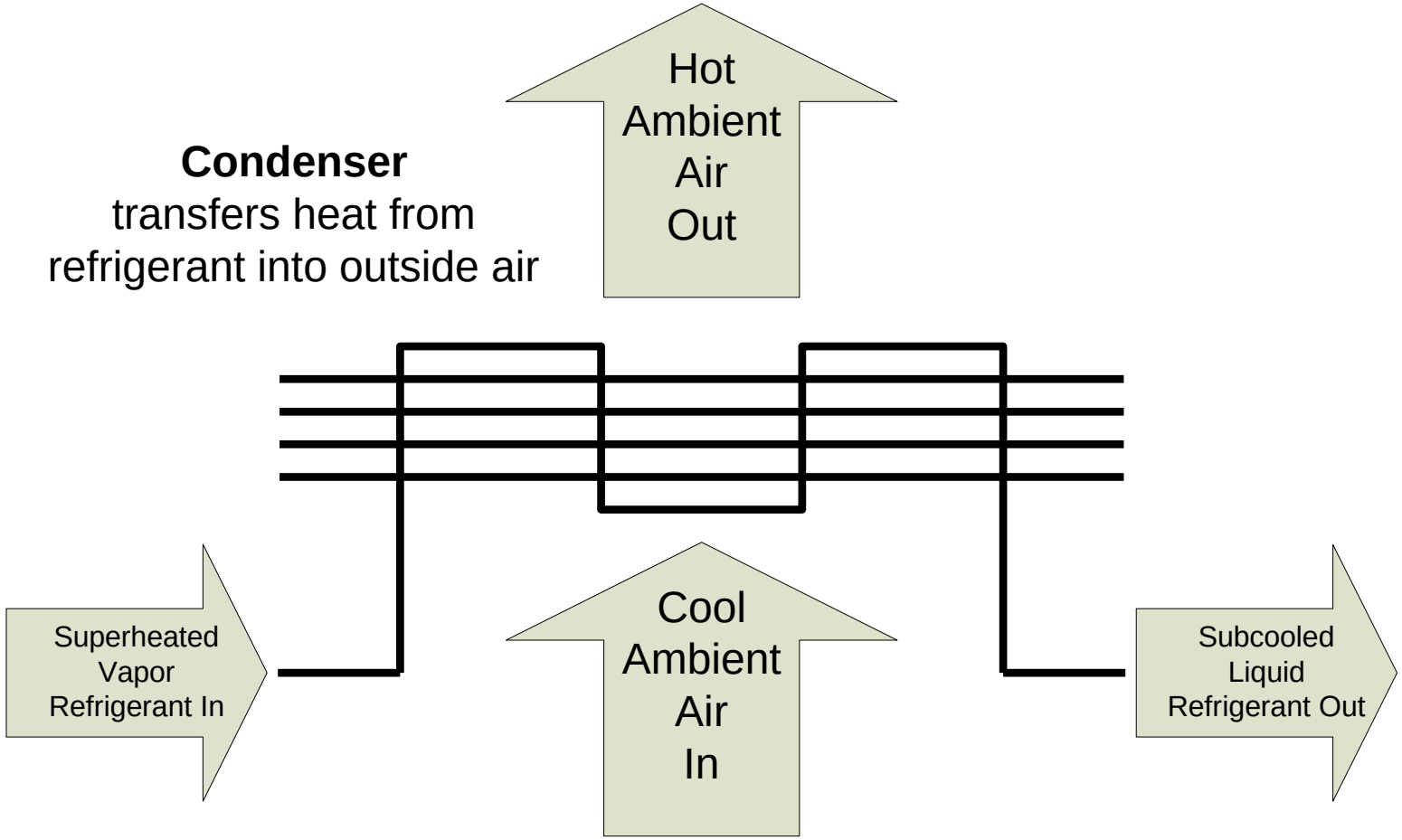


Evaporator transfers heat from conditioned space to refrigerant

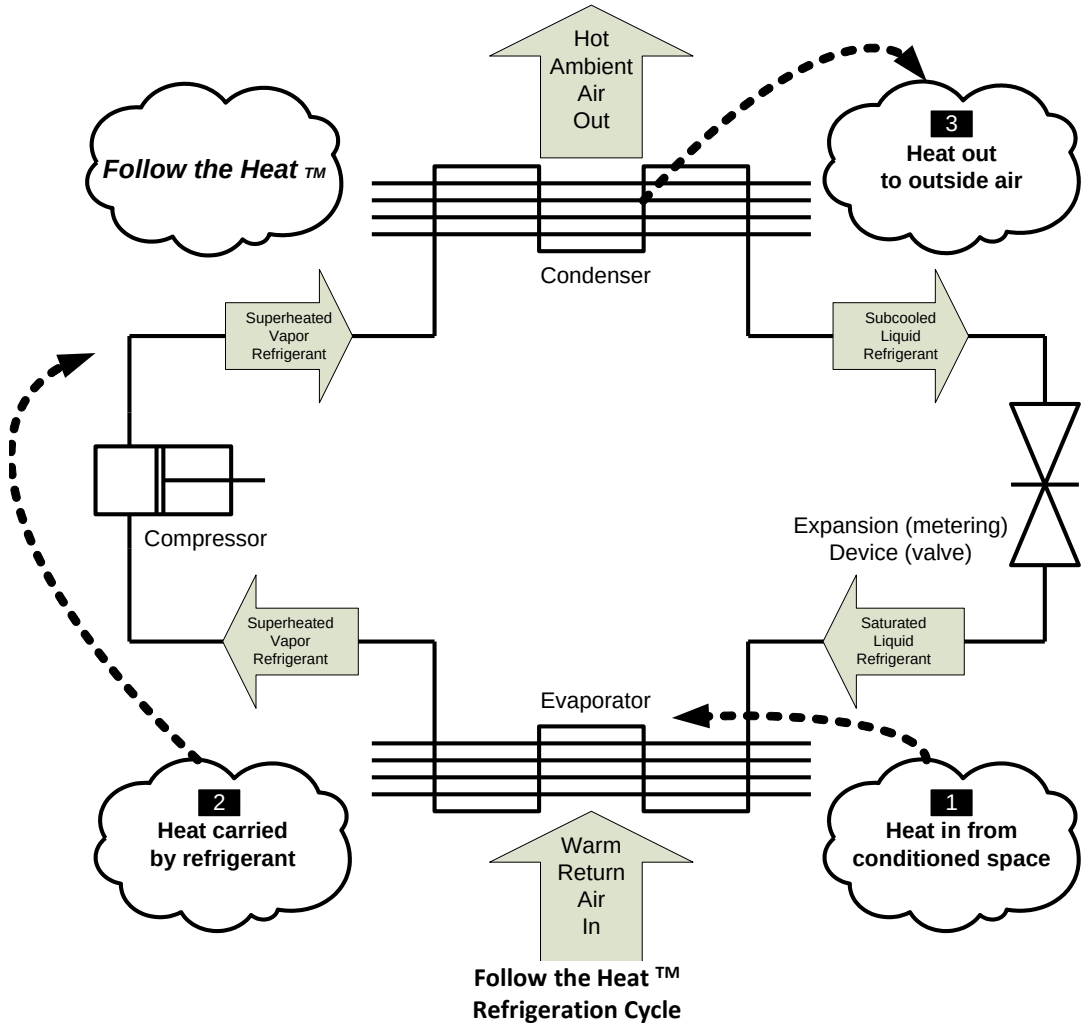
Follow the Heat ™ Evaporator

Follow-the-Heat

Condenser
transfers heat from
refrigerant into outside air



Follow-the-Heat



Follow the Heat ™
Refrigeration Cycle

Heat Transfer

Superheat

Heat added to a vapor, causing an increase in temperature

Saturation

The point at which a substance can not accept or reject heat without changing state

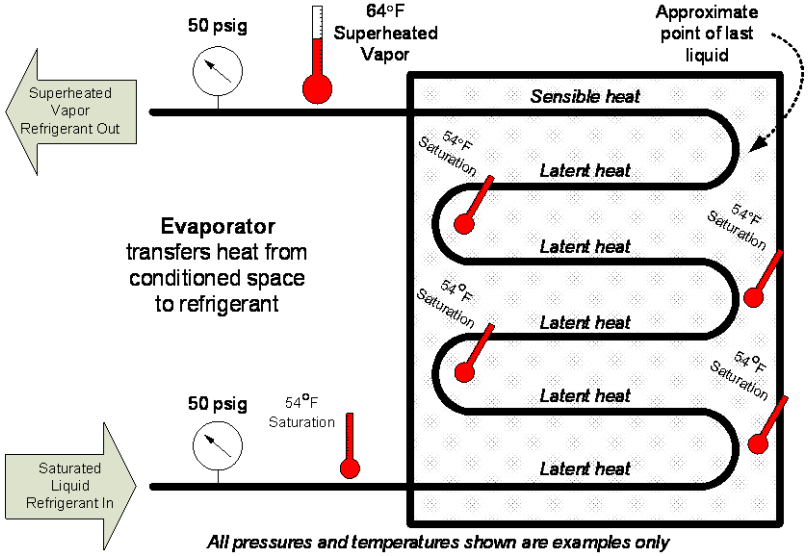
Subcooling

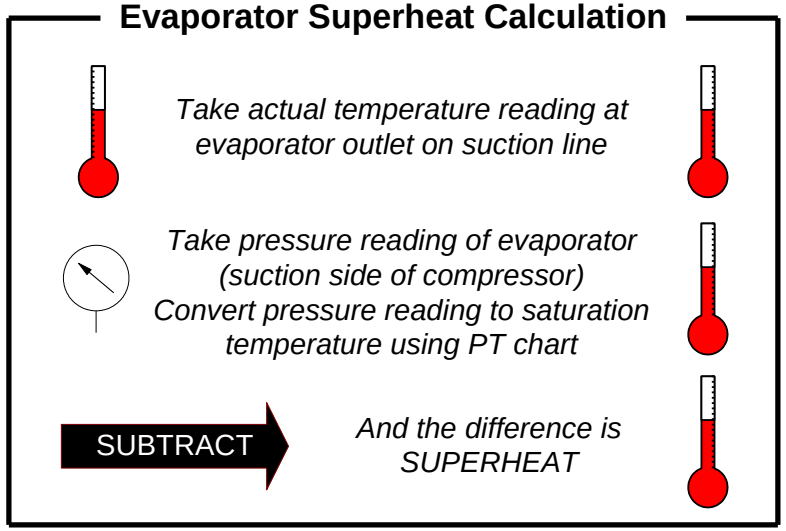
Heat removed from a liquid , causing a decrease in temperature

Evaporator Superheat

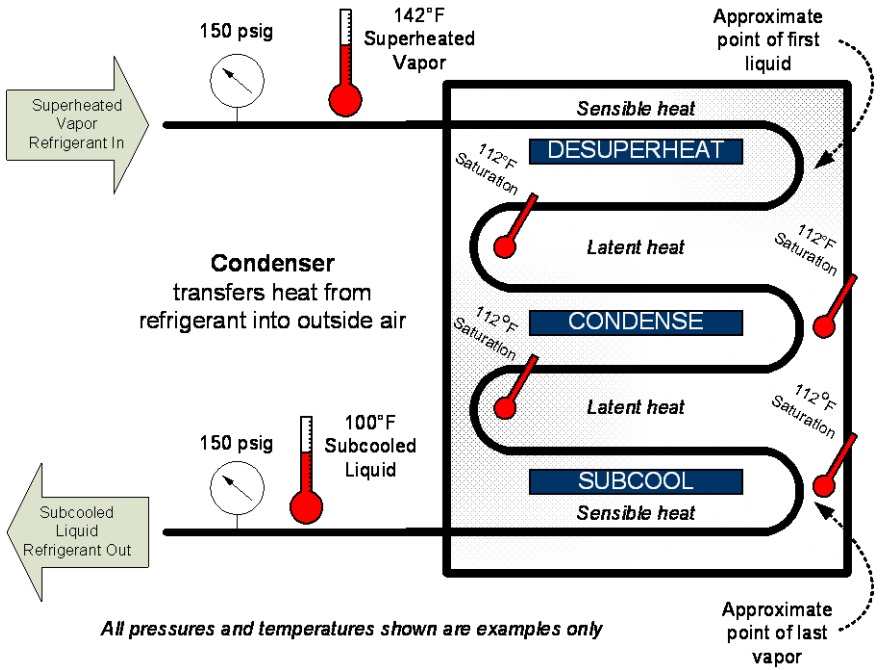
Evaporator Superheat Example

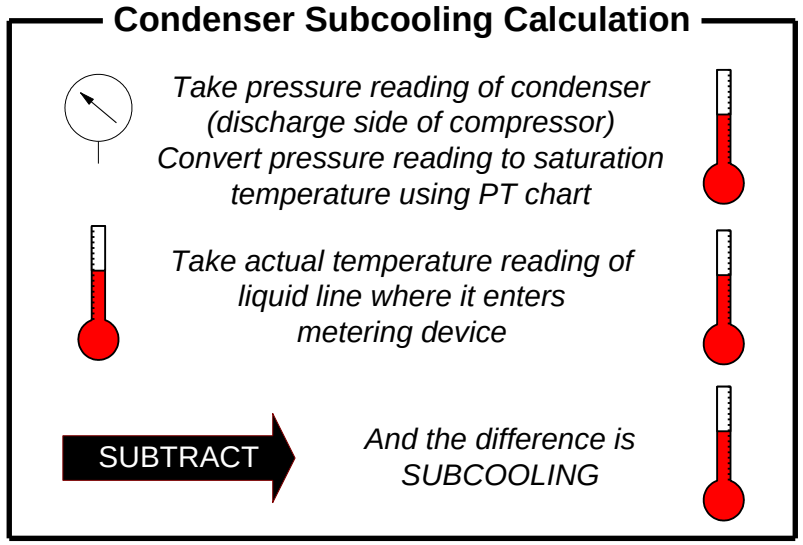
Actual suction line temperature: 64° F
Minus suction pressure (50 psig for R-134a)
converted to saturation temperature: 54° F
SUPERHEAT……10° F





Condensers





Subcooling Example

High side (head) pressure
(150 psig for R-134a)
converted to saturation temperature: 112° F
Minus actual liquid line temperature: - 100° F

SUBCOOLING…… 12 ° F

Symptom	SUCTION PSI	SUPER HEAT	HEAD PSI	SUB COOL	AMPS
Restricted Cond. Coil	↑	↓	↑	↓	↑
Restricted Evap. Coil	↓	↓	↓	↓	↑
Heavy Load	↑	↑	↑	↑	↑
Light Load	↓	↓	↓	↓	
Noncondensable	↑	↓	↑	↓	↑
Undercharge	↓	↑	↓	↓	↓
Overcharge	↑	↓	↑	↑	↑
Bad Valves	↑	↔	↓	↔	↓
Liquid Line Restriction	↓	↑	↓	↑	↓
Suction Line Restriction	↓	↑	↓	↑	↓
Overfeeding Metering Device	↑	↓	↓	↓	↑
Missed Refrigerants	↓	↔	↓	↔	
Underful Metering Device	↓	↑	↓	↑	↓
Low Outdoor Ambient	↓	↑	↓	↑	↓

Questions?

- If you'd like to learn more about air conditioning and refrigeration, TPC Training can help!

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