# Refrigeration and Air Conditioning

## ME 268 (Model Lab)

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BUET

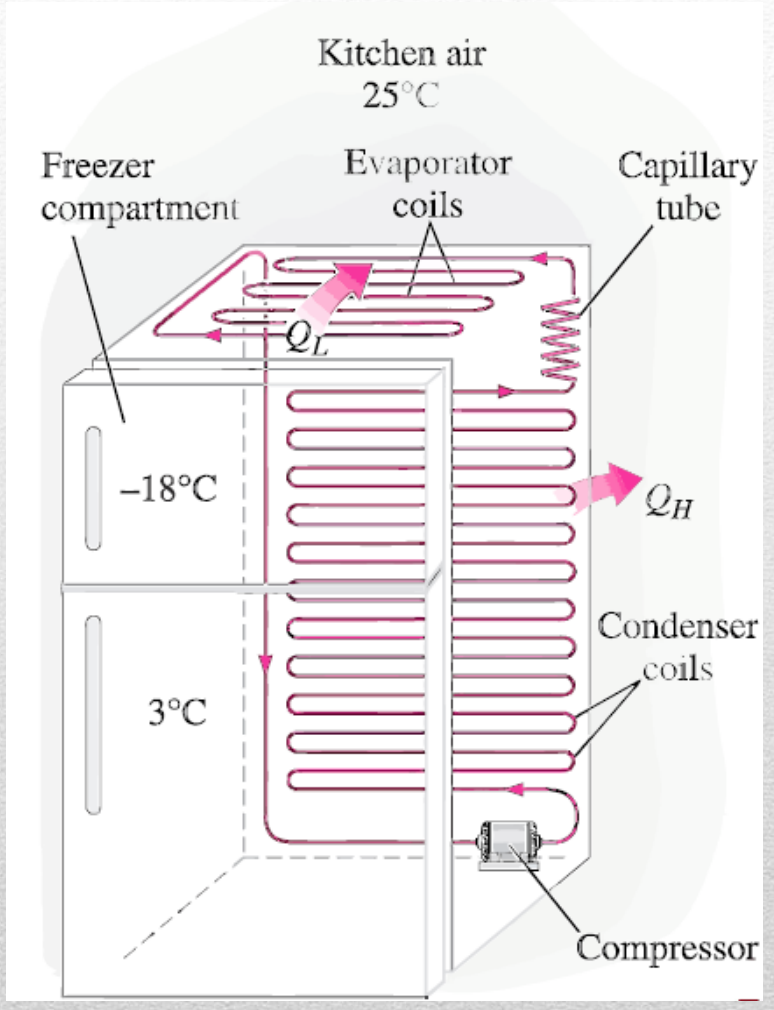
# Refrigeration:

Refrigeration is a process of reducing and maintaining low temperature of a space or material below the temperature of the surroundings.

“Refrigeration is the process of removing heat from an enclosed space, or from a substance, and rejecting it elsewhere for the purpose of lowering the temperature of the enclosed space or substance and then maintaining that lower temperature.”

## Applications:

1. Domestic Refrigeration

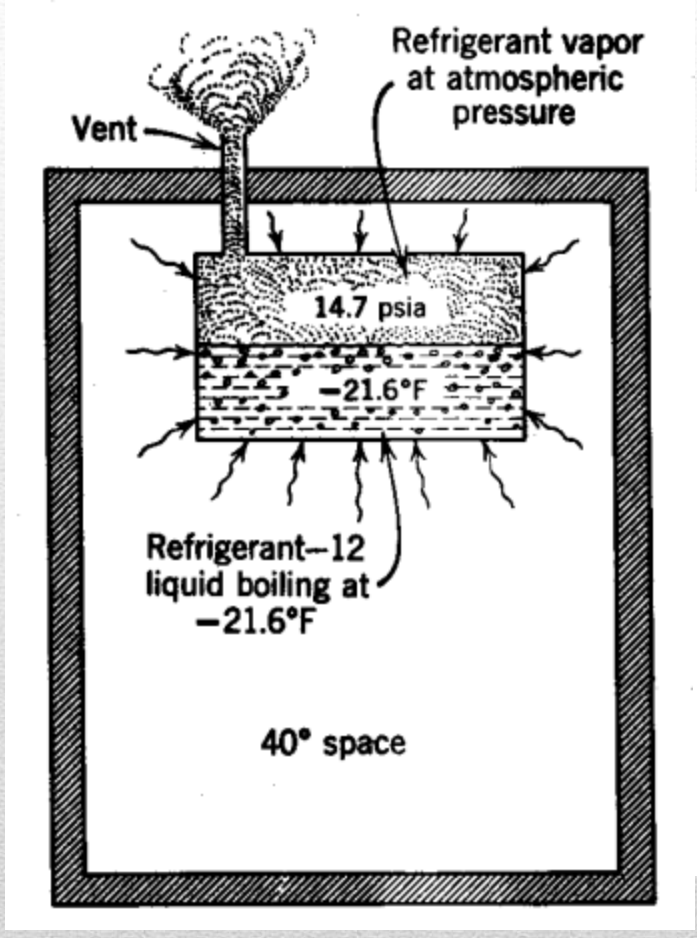


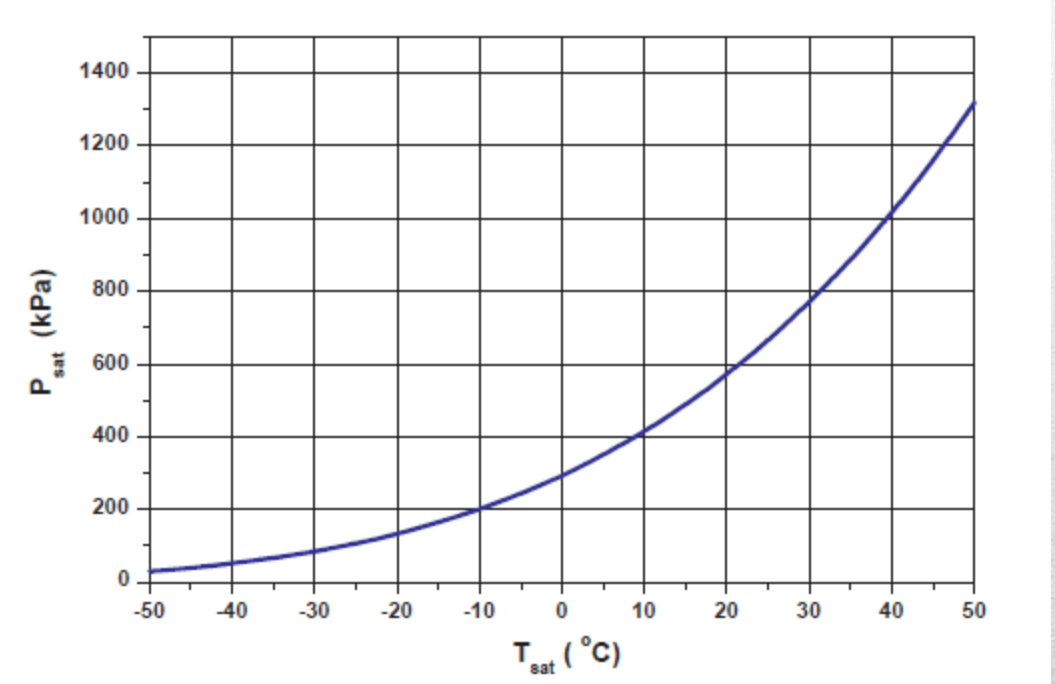
# 2. Commercial Refrigeration

- Meats, poultry and fish all must be kept in climate-controlled environments before being sold.

# 3. Industrial Refrigeration

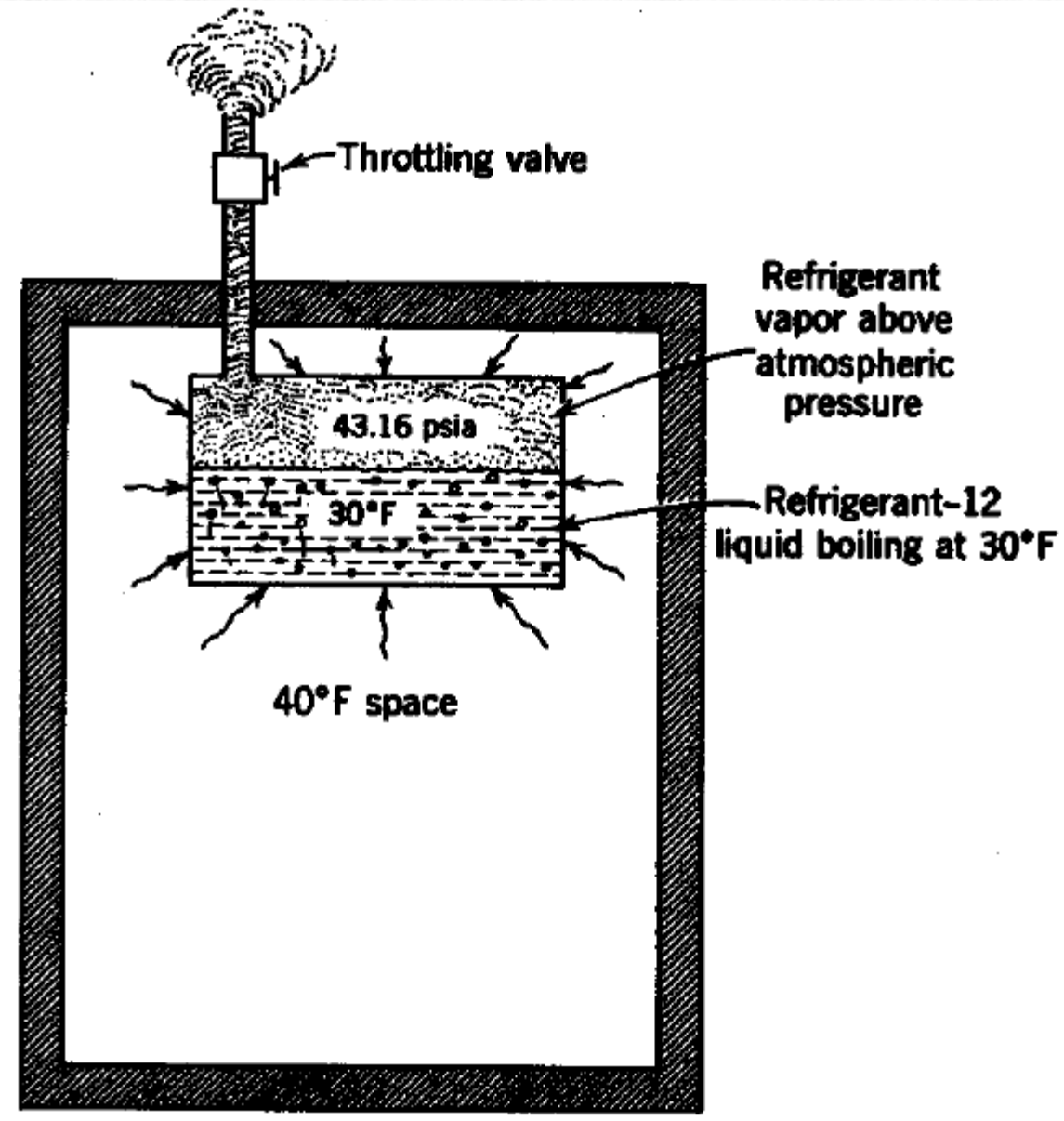

# Refrigeration Basics



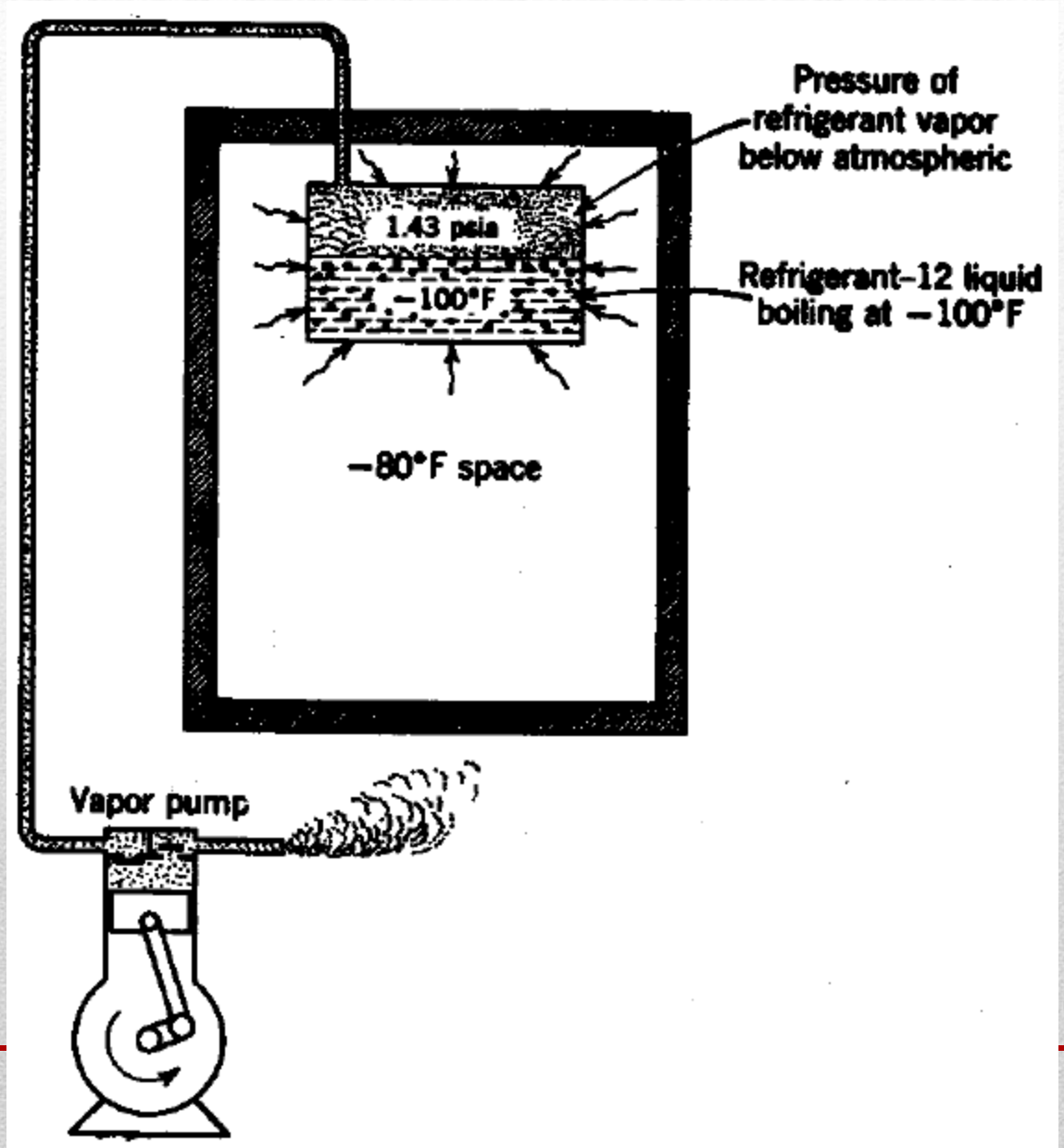



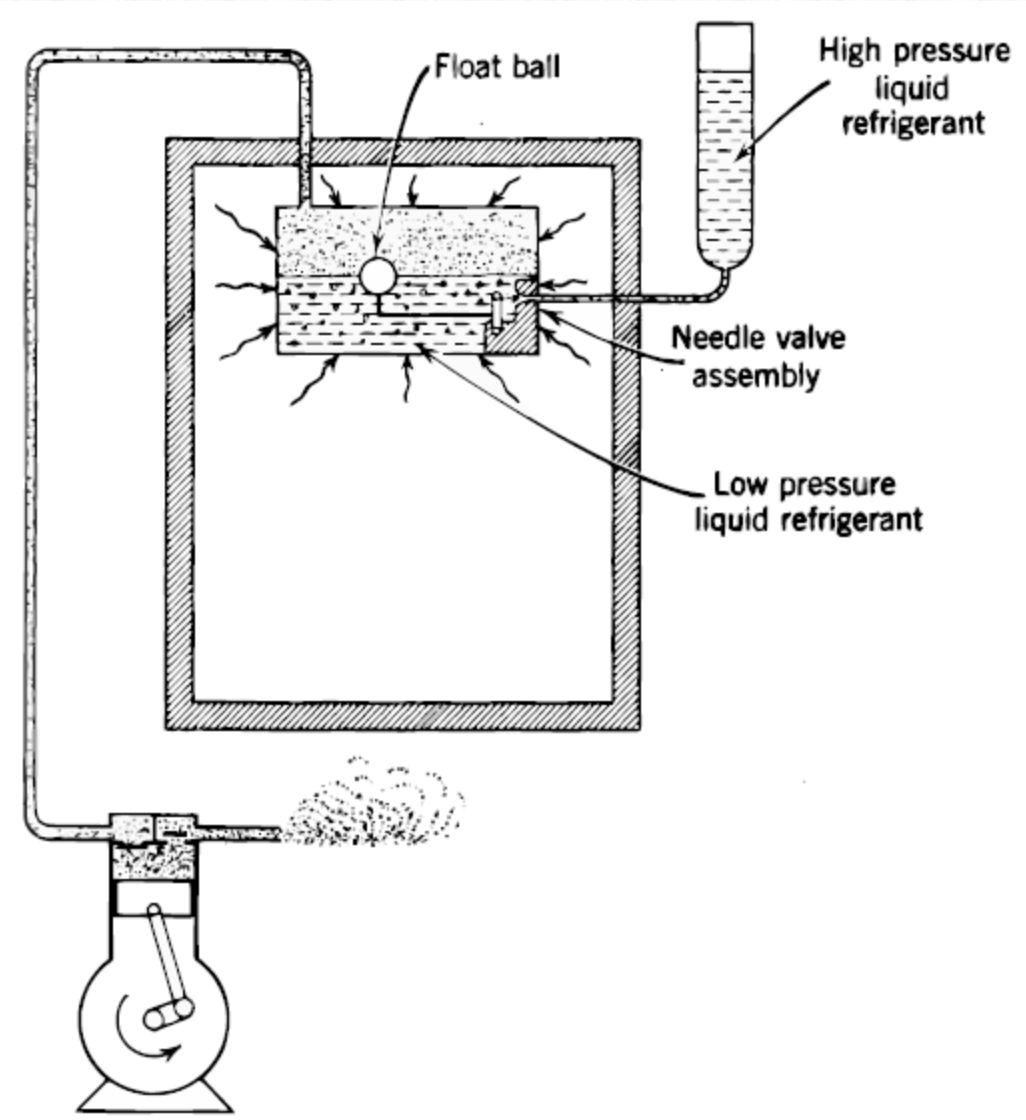

Refrigerant boils & condenses at different temperatures at different pressures. During boiling/condensation it absorbs/rejects latent heat.

# Refrigeration Basics



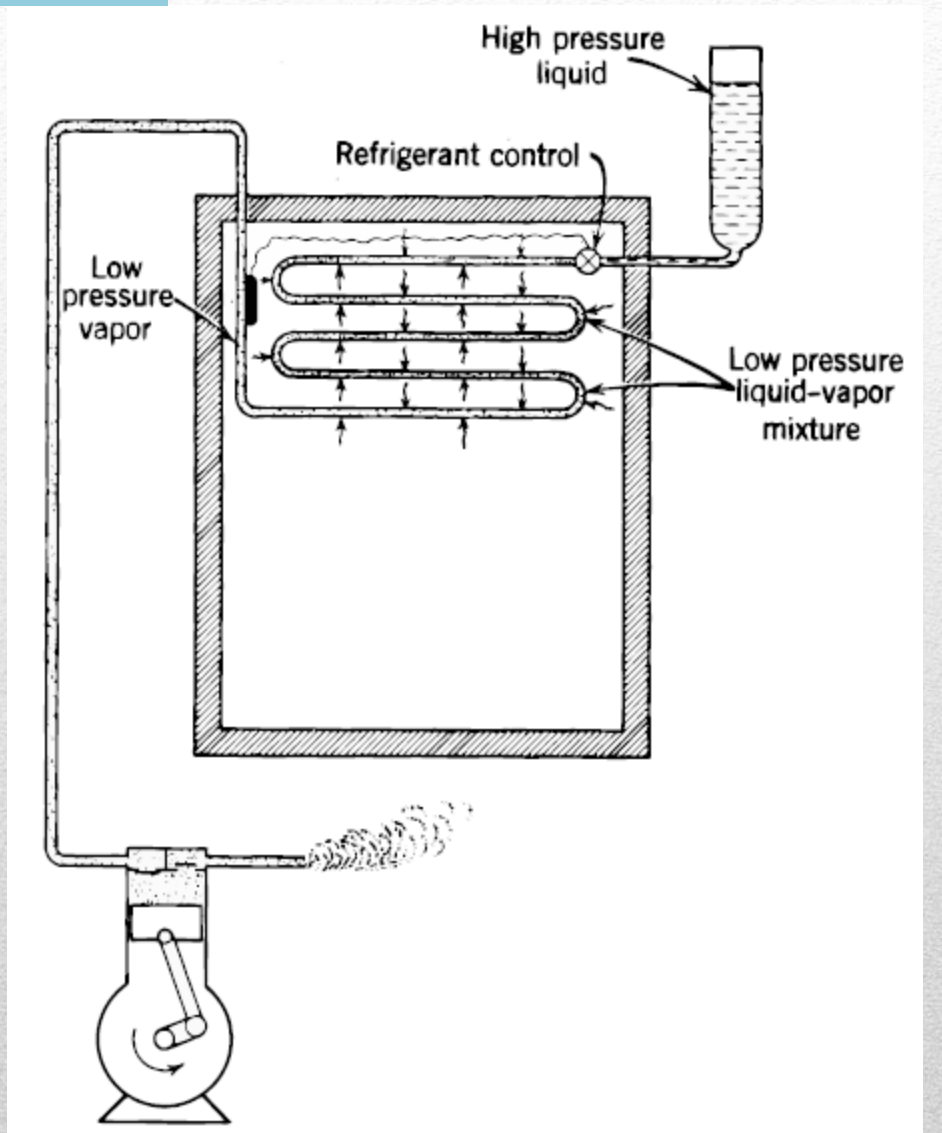
# Refrigeration Basics



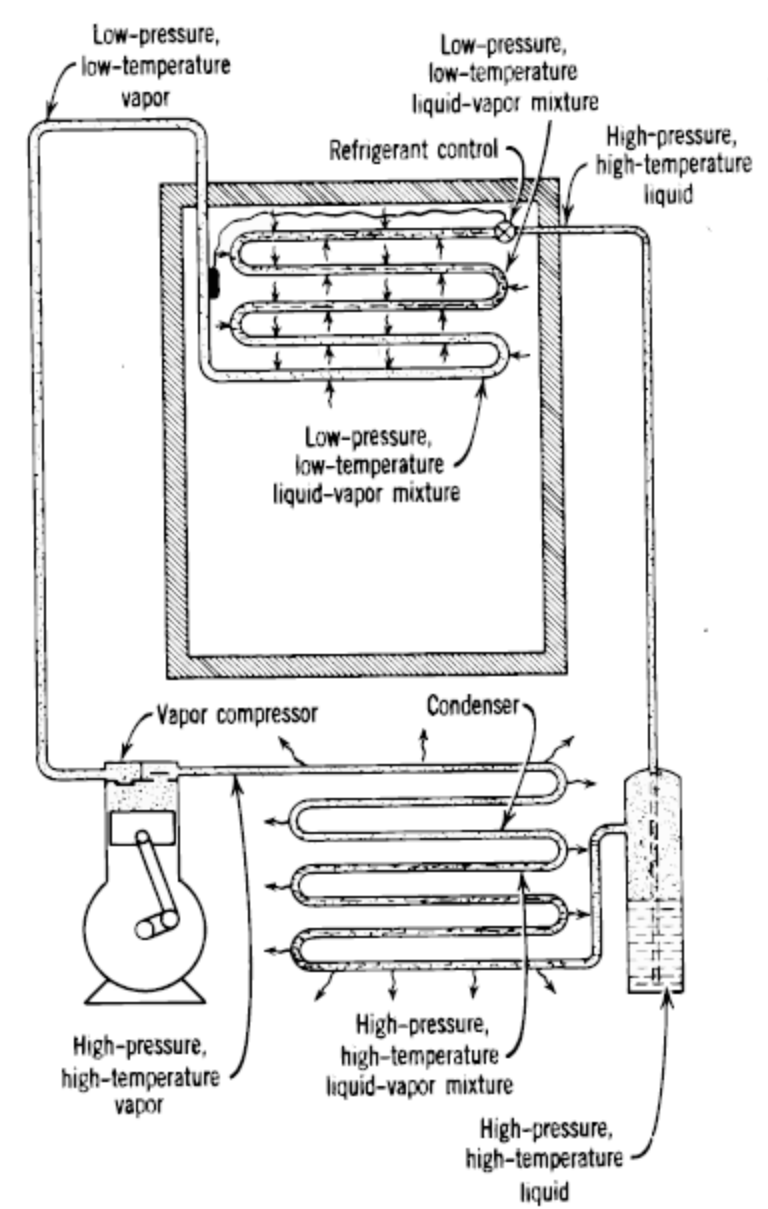



*Float Valve to maintain liquid level*

# Refrigeration Basics

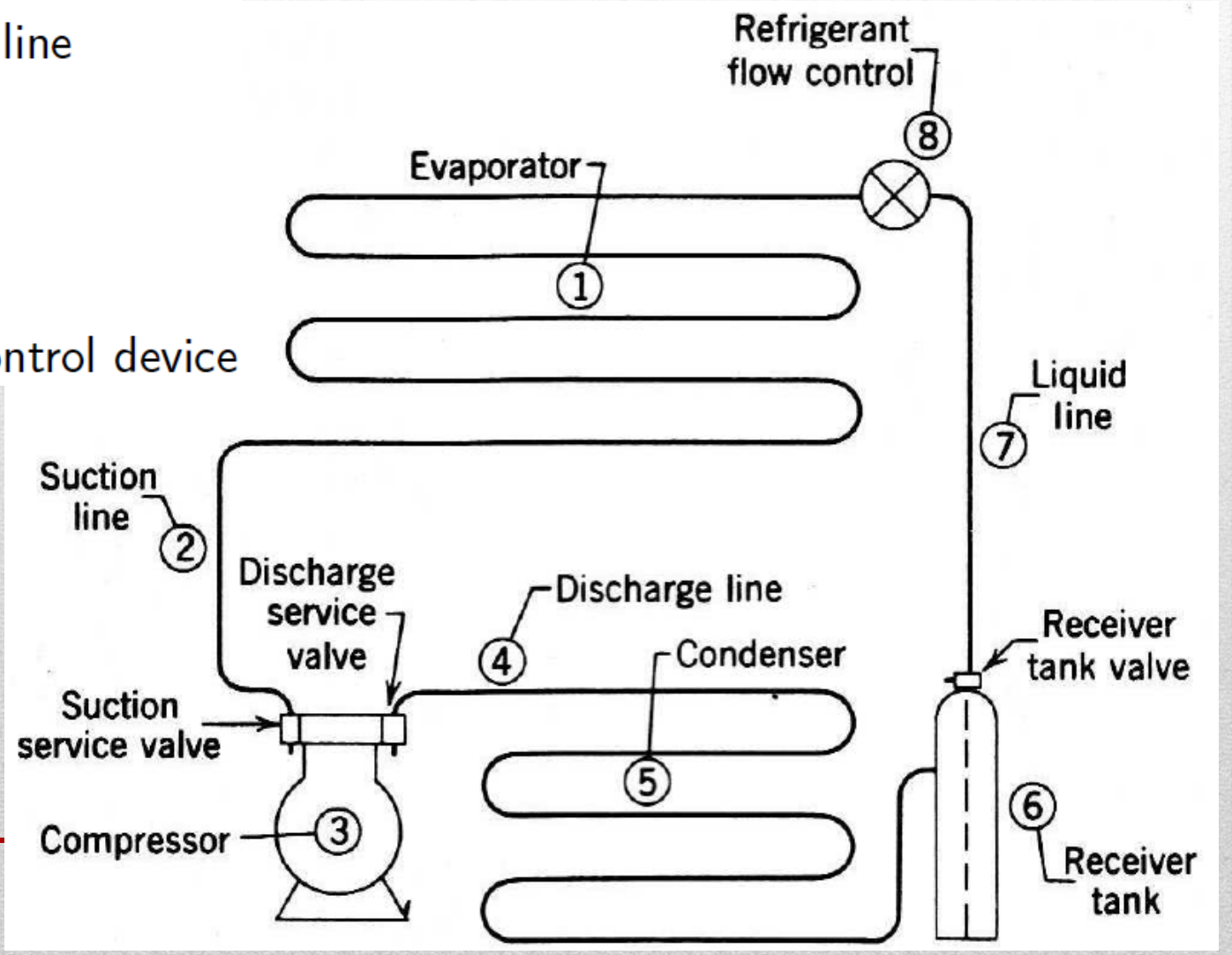


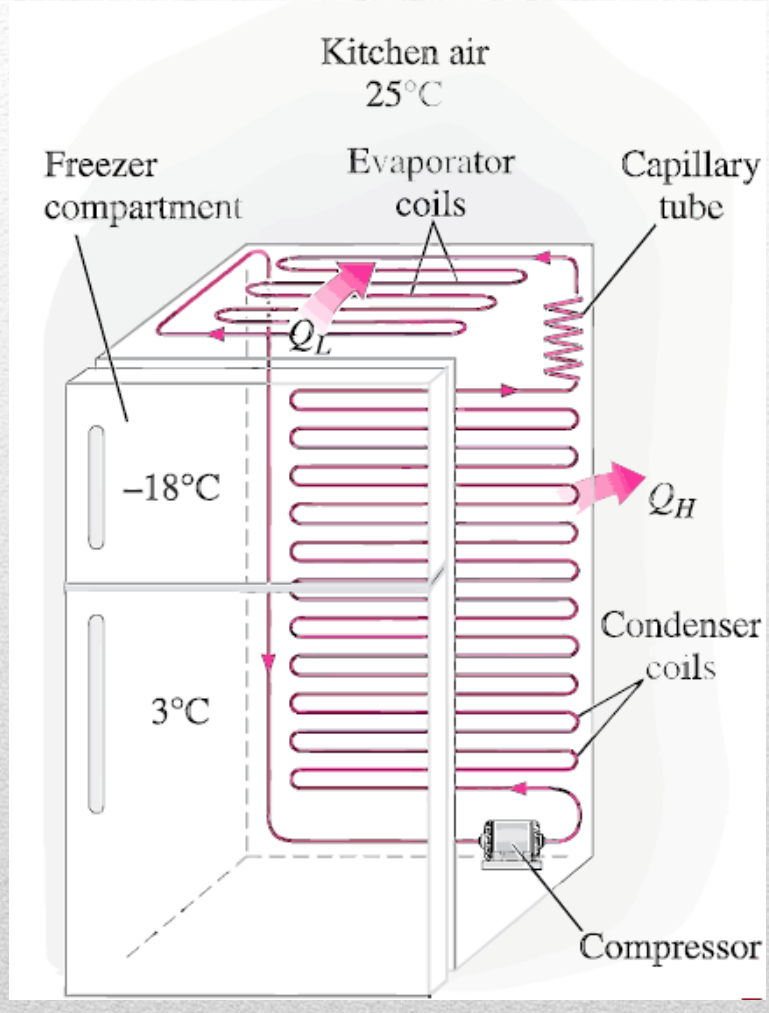
# Basic Components of a Refrigeration System

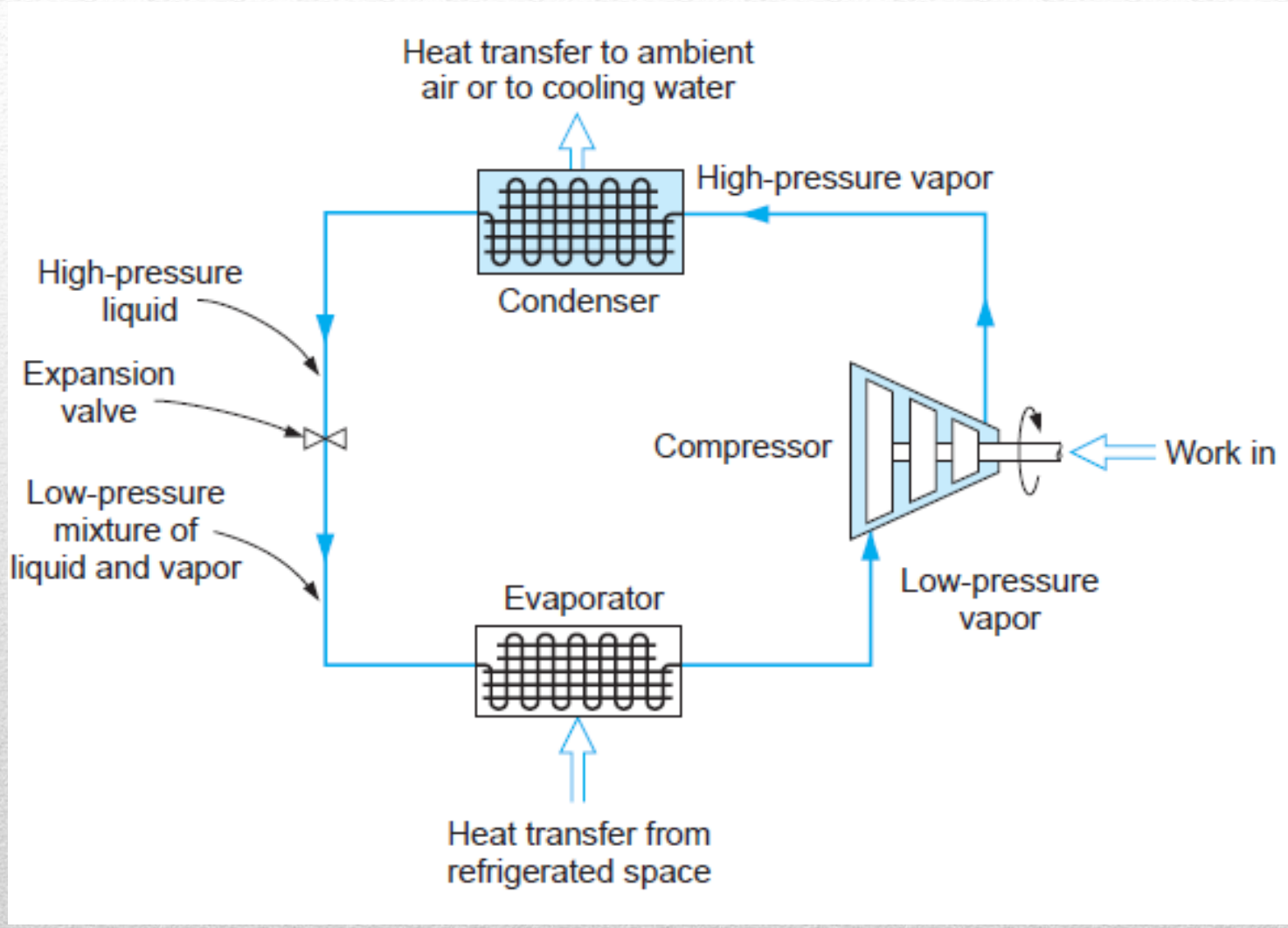


# Key Components of Refrigeration System

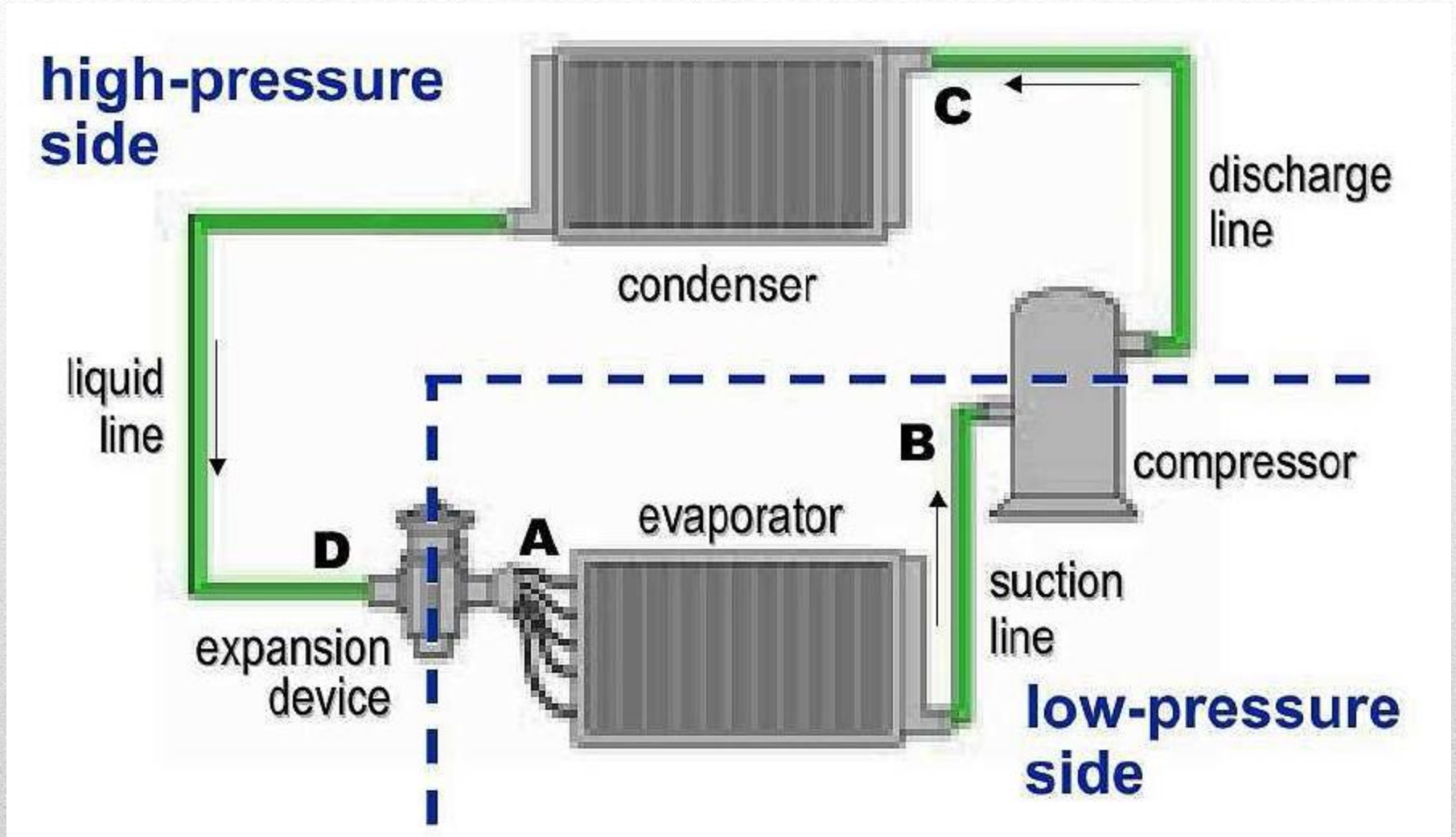
1. Evaporator
2. Suction line
3. Vapour compressor
4. Hot gas/discharge line
5. Condenser
6. Receiver tank
7. Liquid line
8. Refrigerant flow control device



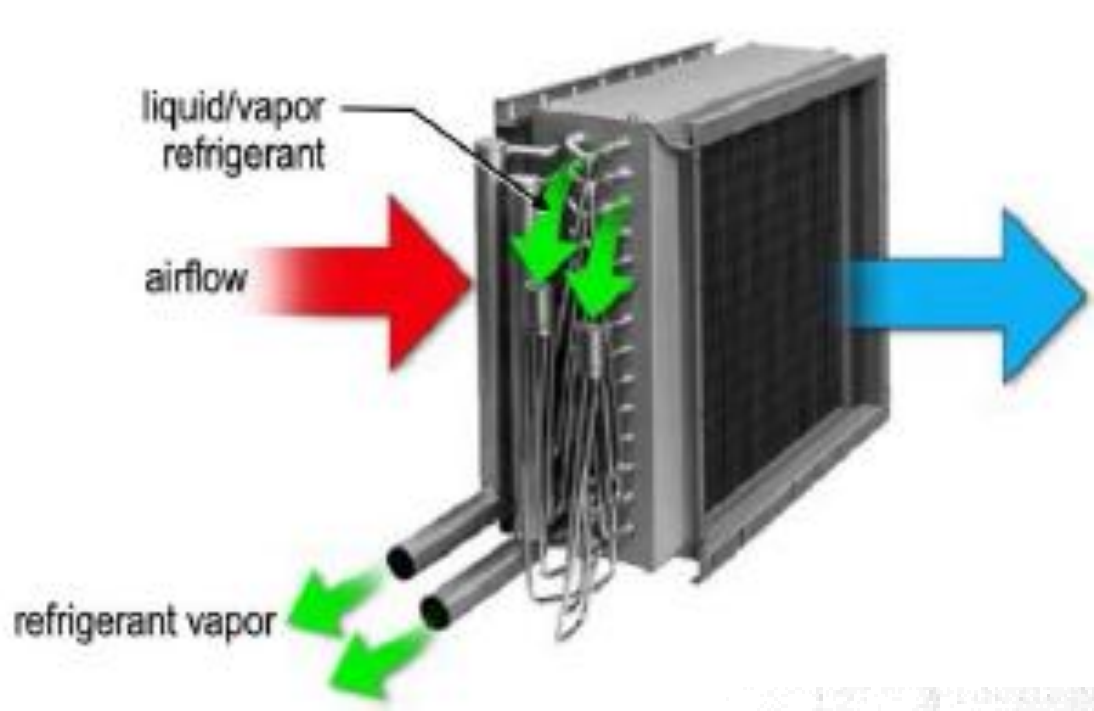

Kitchen air
25°C
Freezer
compartment
Evaporator
coils
Capillary
tube
$Q_L$
−18°C
$Q_H$
Condenser
coils
3°C
Compressor

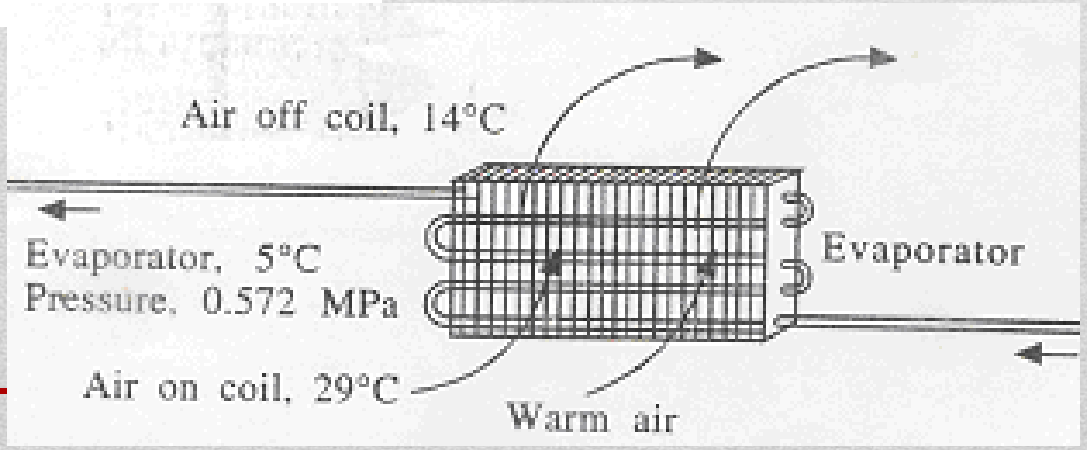

Heat transfer to ambient
air or to cooling water
High-pressure vapor
Condenser
High-pressure
liquid
Expansion
valve
Compressor
Work in
Low-pressure
mixture of
liquid and vapor
Low-pressure
vapor
Evaporator
Heat transfer from
refrigerated space

# Components of Vapour Compression (VC) System

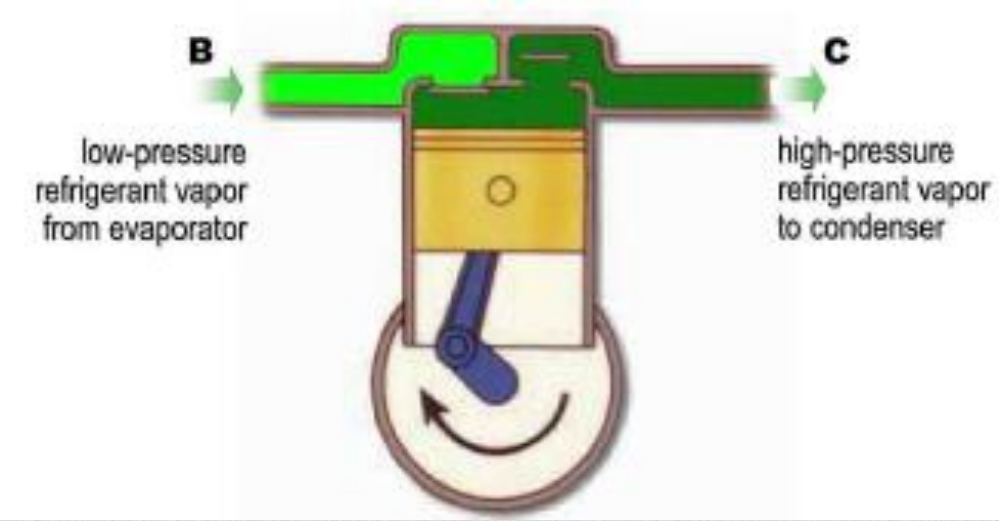


# Evaporator:

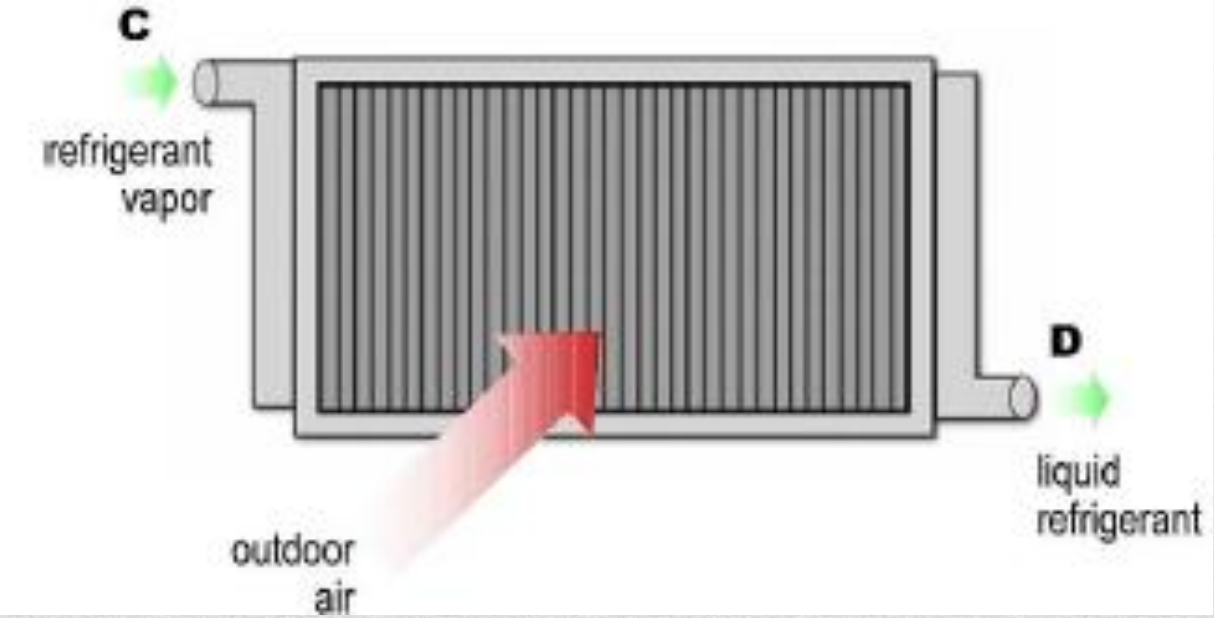

liquid/vapor
refrigerant
airflow
refrigerant vapor

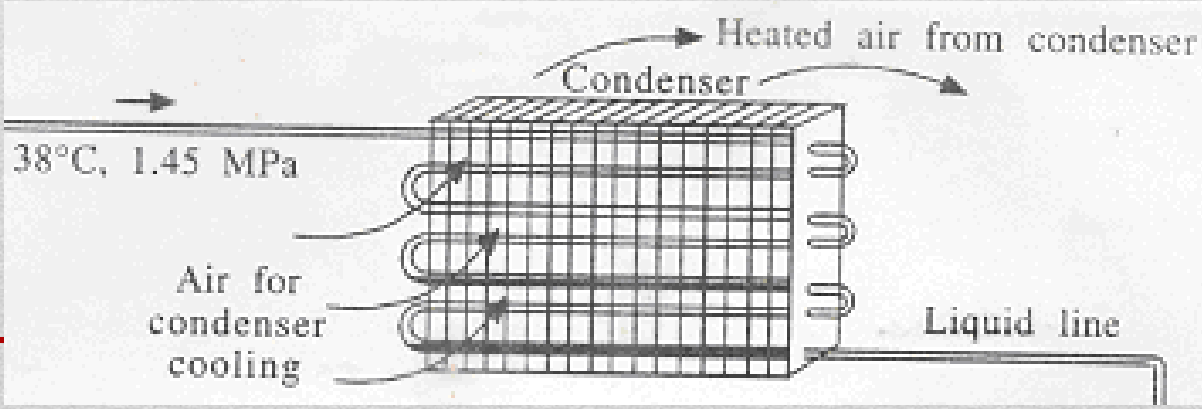

Air off coil, 14°C
Evaporator, 5°C
Pressure, 0.572 MPa
Evaporator
Air on coil, 29°C
Warm air

# Compressor:

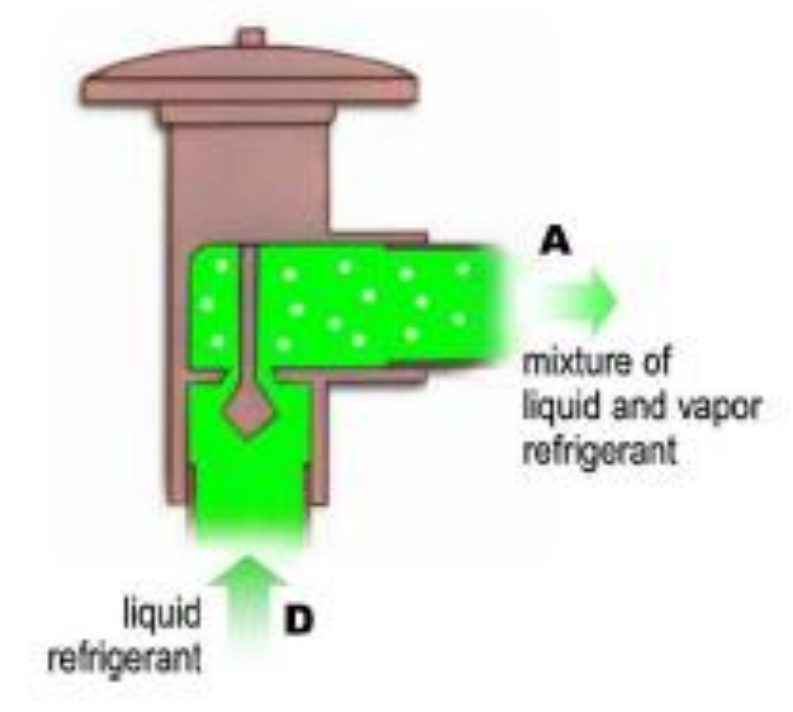

B
C
low-pressure
refrigerant vapor
from evaporator
high-pressure
refrigerant vapor
to condenser

# Condenser:


C
refrigerant
vapor
D
liquid
refrigerant
outdoor
air


Heated air from condenser
Condenser
38°C, 1.45 MPa
Air for
condenser
cooling
Liquid line

# Expansion Valve:



# Unit of Refrigeration:

The *ton* measure of refrigeration originates from the English system of units. One ton of refrigeration produces the same cooling effect as the melting of 1 ton (2000 $lb_m$) of ice over a 24-hour period.

Melting 1 lb of ice requires 144 Btu. So, when 1 ton ice melts, amount of heat absorbed:

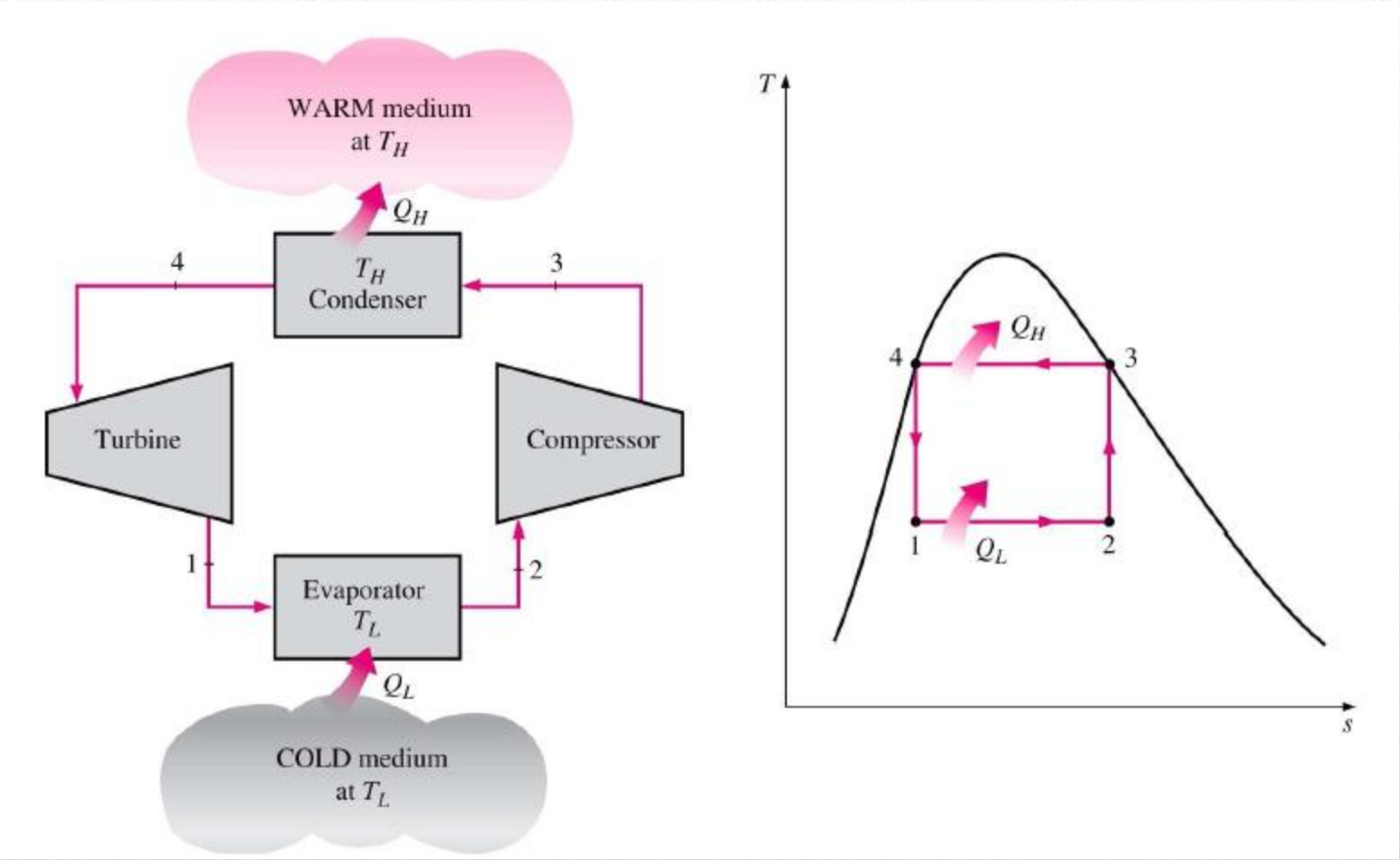
$$2000*144 = 288000 \text{ Btu}$$

when this heat is absorbed over 24 hours, it becomes

$$\begin{aligned} 288000/24 &= 12000 \text{ Btu/hr} \\ &= 12000*1055 \text{ J/hr} \\ &= (12*1055/60) \text{ kJ/min} \\ &= 211 \text{ kJ/min} \\ &= 3.517 \text{ kW} \end{aligned}$$

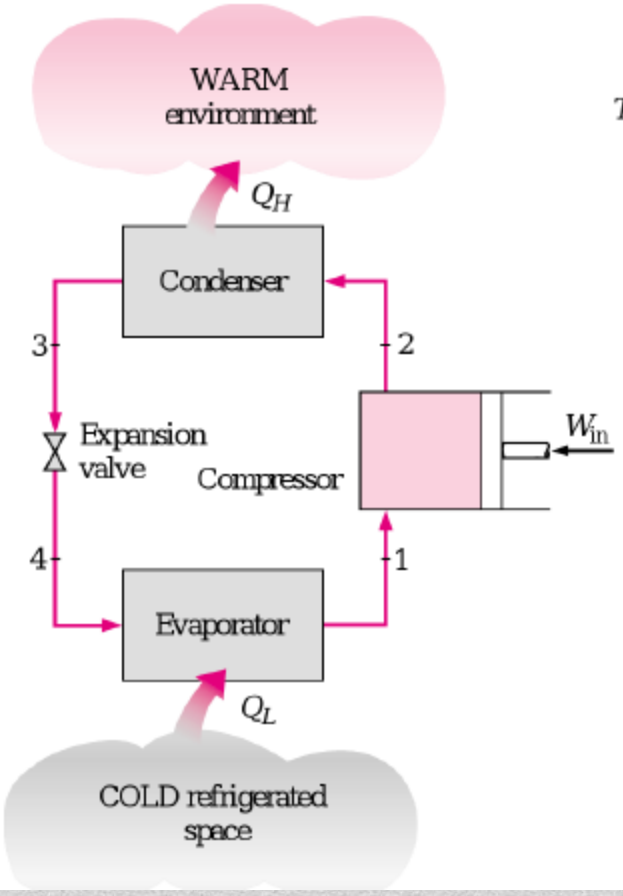
Therefore, 1 ton of refrigeration is defined as the transfer of heat at the rate of 3.517 kW.

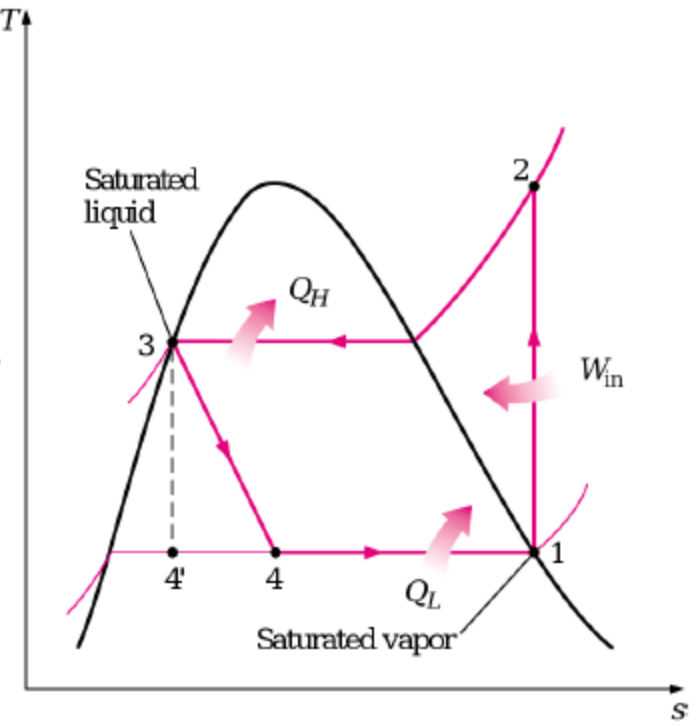
# Reversed Carnot Cycle



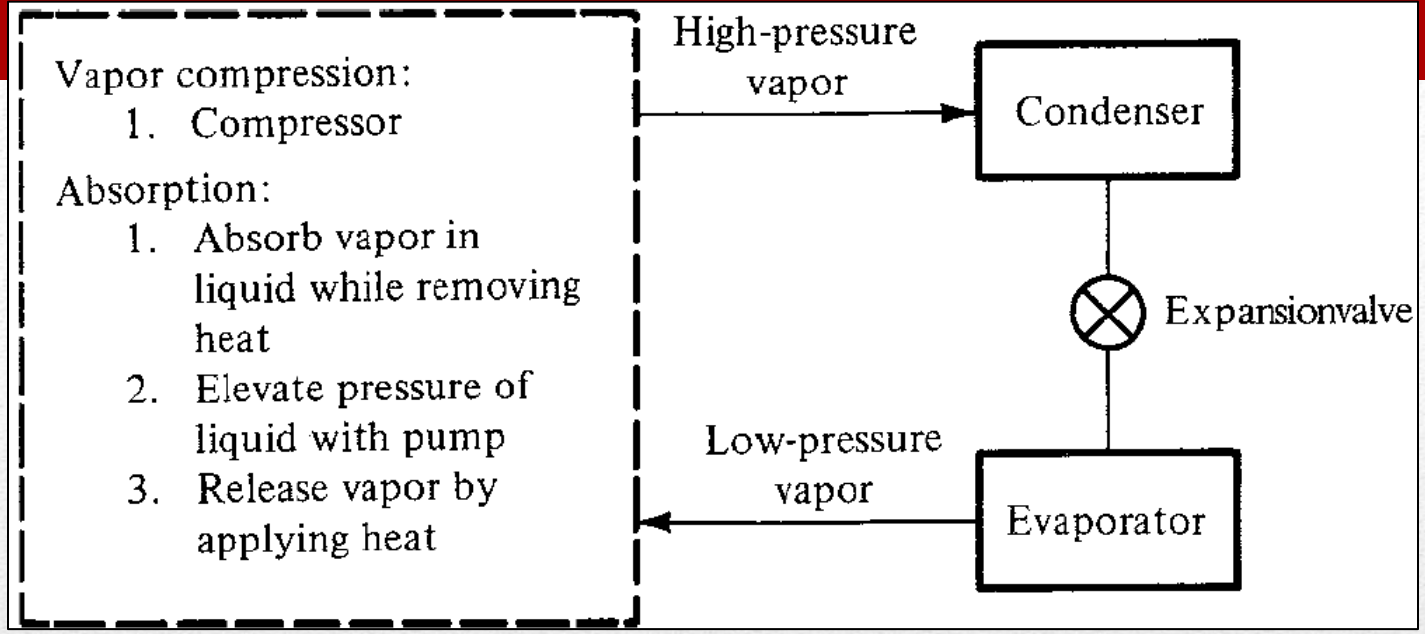

1–2 Isothermal heat addition at lower temperature
2–3 Isentropic compression to higher temperature
3–4 Isothermal heat rejection at higher temperature
4–1 Isentropic expansion to lower temperature

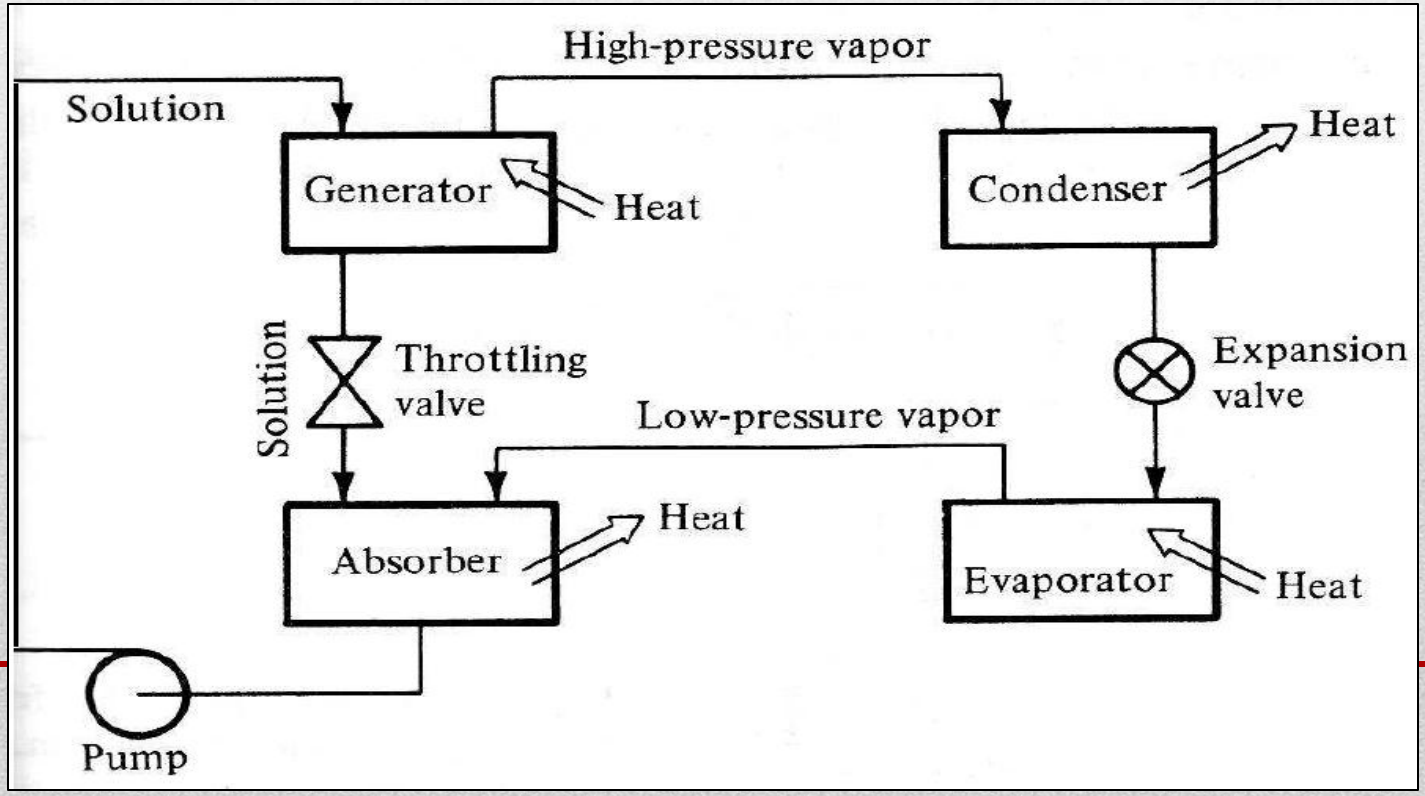
# Ideal Vapour Compression Refrigeration Cycle



Vapor Absorption Refrigeration




Vapor Absorption Refrigeration

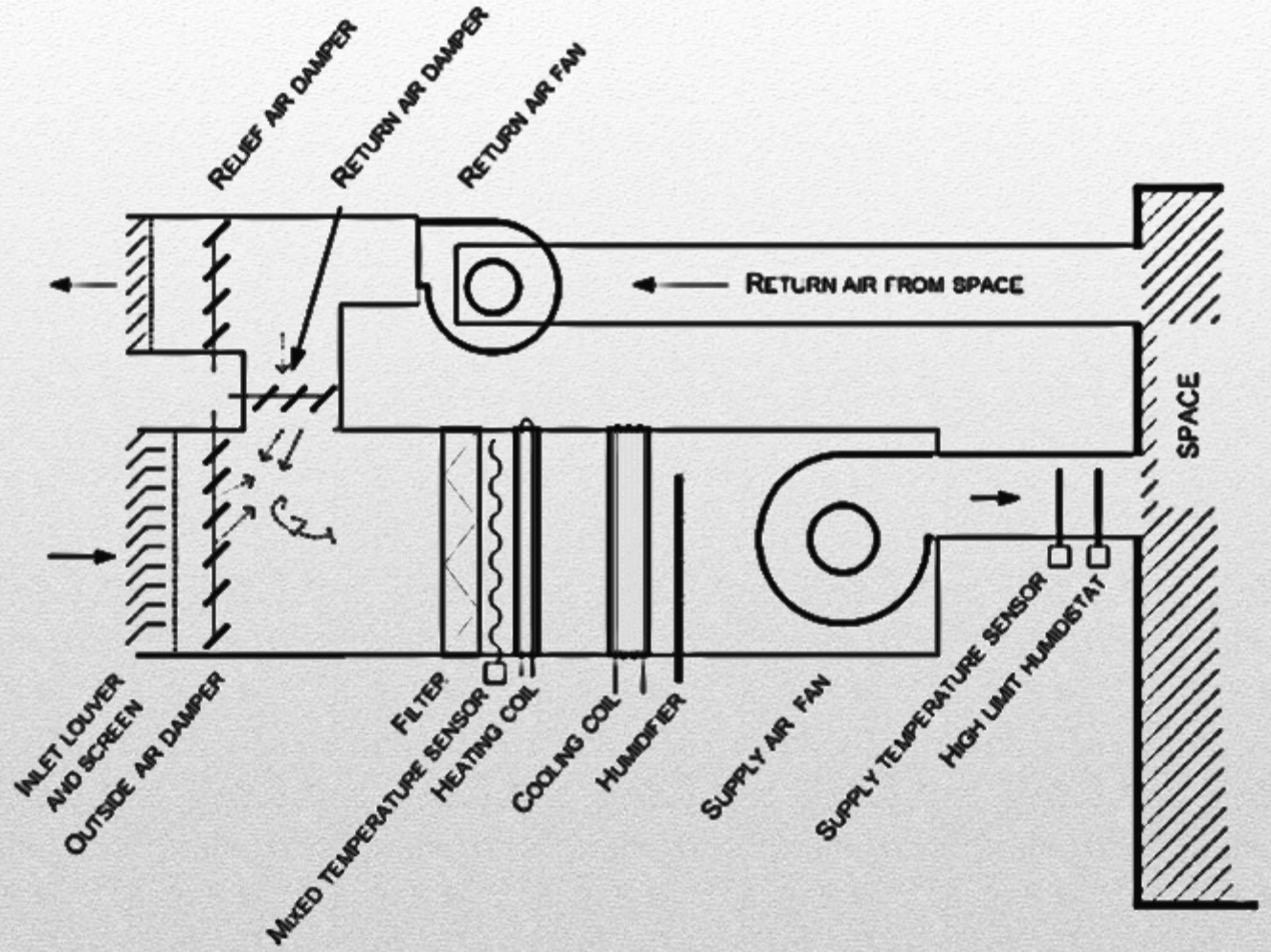
# Air Conditioning:

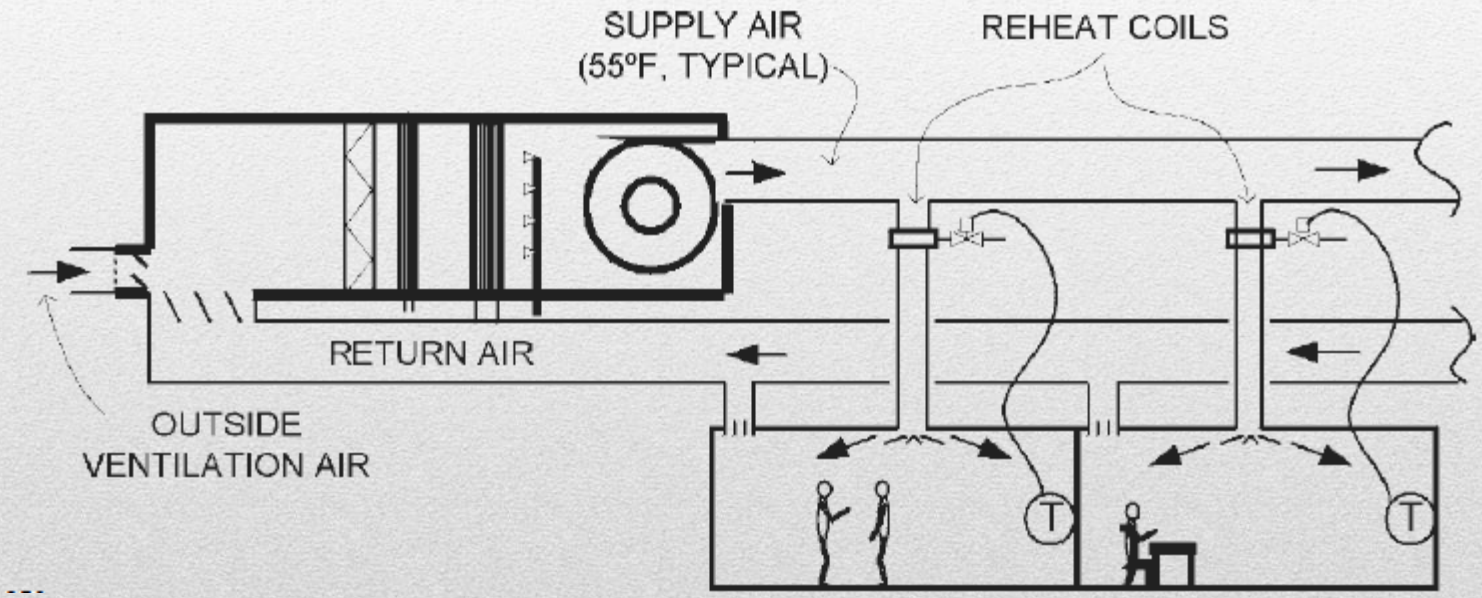
Air Conditioning is the most important application of refrigeration.

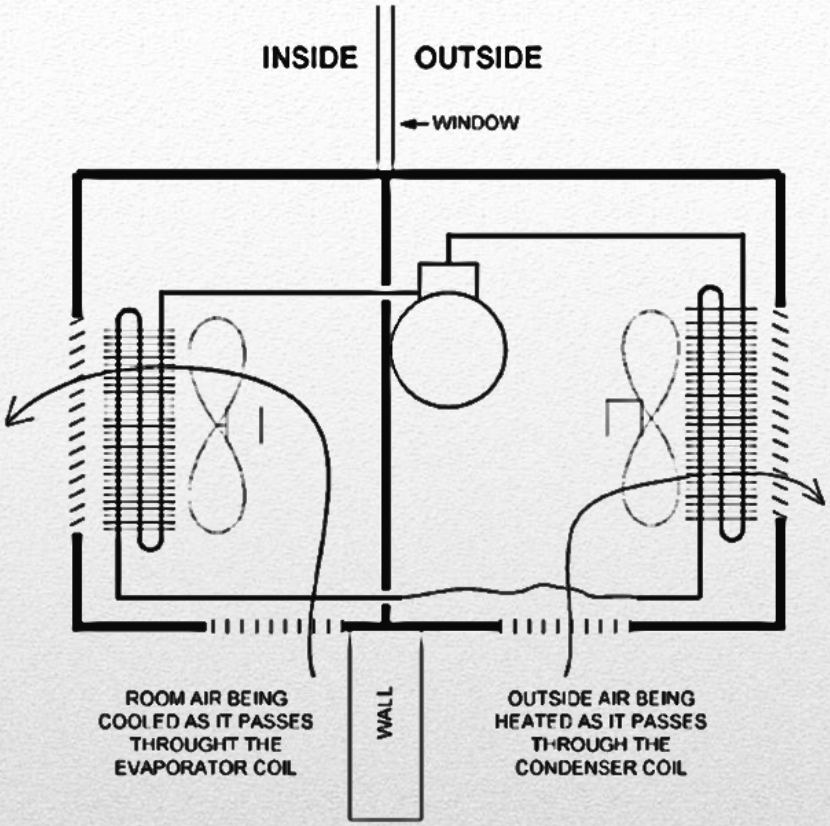
“Air Conditioning is the process of air treatment which controls the temperature, humidity, cleanliness and distribution of the air simultaneously to meet the requirements of a conditioned space.”

An air conditioner serves the purpose of an air cooler, air heater and an air cleaner.

# Basic Air Conditioning System (AHU):

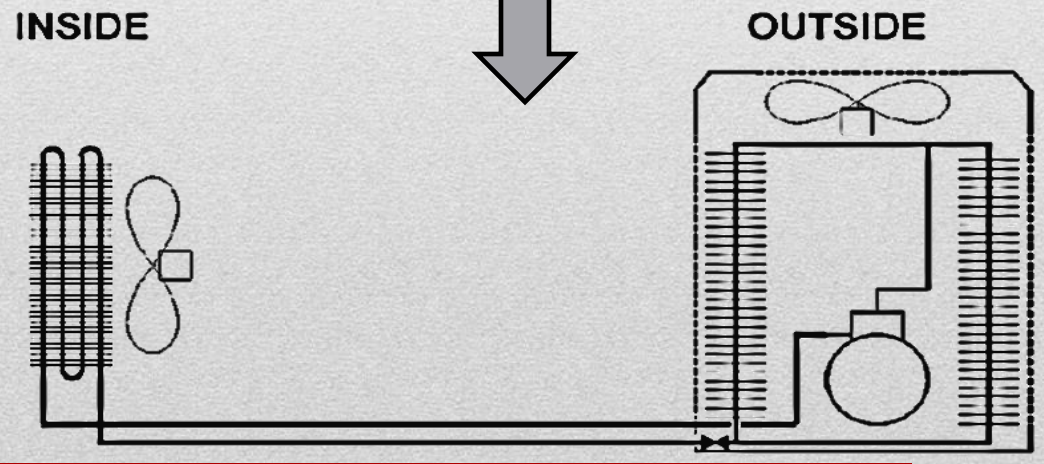


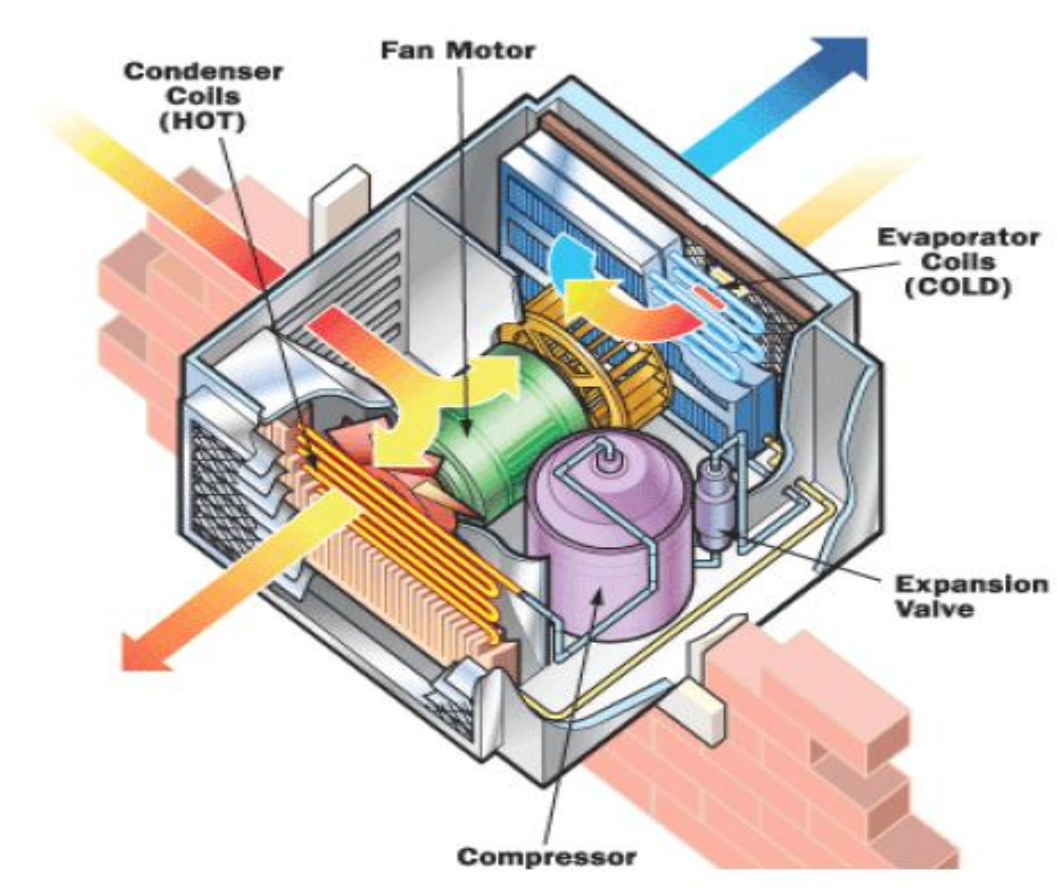

SUPPLY AIR
(55ºF, TYPICAL)
REHEAT COILS
RETURN AIR
OUTSIDE
VENTILATION AIR
T
T



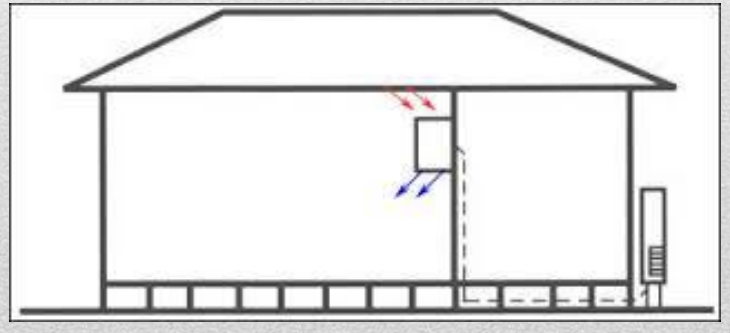

**Window type AC**

**Split type AC:** The noise of the compressor is outside and can be located at some distance from the AHU.




Condenser
Coils
(HOT)
Fan Motor
Evaporator
Coils
(COLD)
Expansion
Valve
Compressor

# Split type A/C

# Reference


1. Ameen (2006), Refrigeration & Air-conditioning, Prentice Hall.
2. Hundy, Trott & Welch (2008), Refrigeration & Air-conditioning, Butterworth-Heinemann.
3. Stoecker & Jones (1983), Refrigeration & Air-conditioning, McGraw-Hill, Inc.
4. teacher.buet.ac.bd/zahurul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