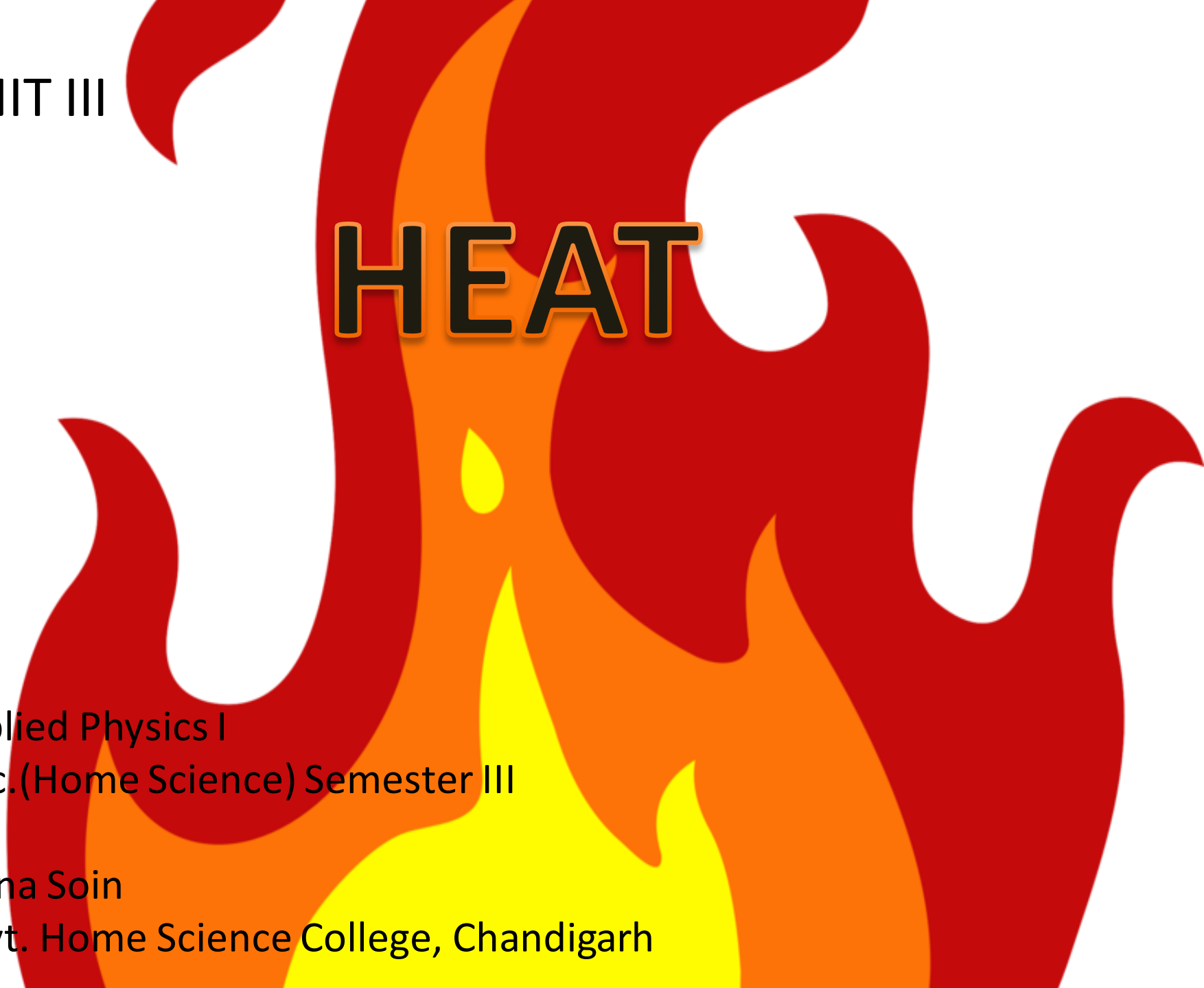
UNIT III

HEAT



Applied Physics I
B.Sc.(Home Science) Semester III

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WHAT IS HEAT ?

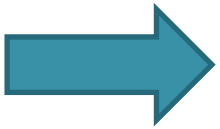
- HEAT is a form of energy which produces in us the sensation of warmth .
- Heat flows spontaneously from a hotter to a colder body.

UNITS :

Heat is a form of energy

SI Unit - Joule (J)

CGS Unit – Calorie (cal)

Heat  Object/Body  Changes

Physical Changes

- Expansion
- Contraction
- Change of state
- Change of electrical properties etc.

Chemical Changes

- Original bonds broken
- New bonds formed
- New products formed etc.

Heat Energy can change into

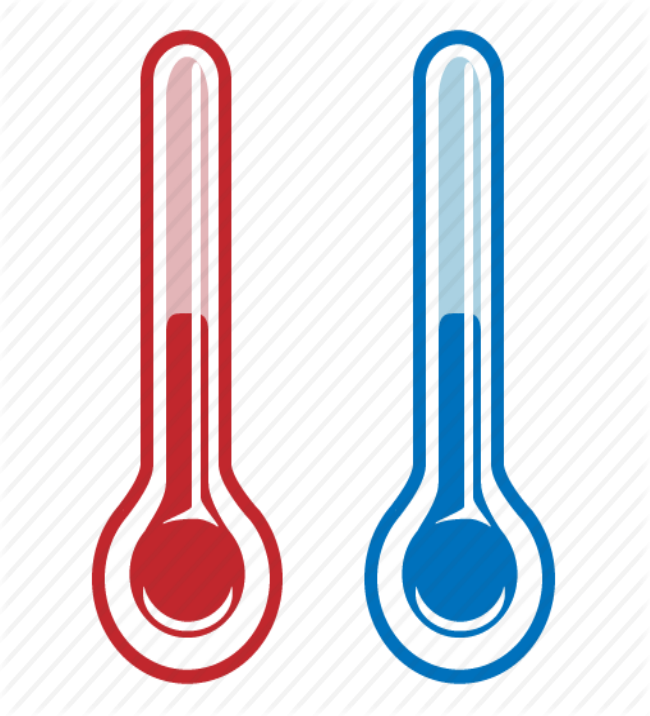
Mechanical energy

Electrical energy

Energy can change from one form to another. Cannot be created or destroyed. Energy is always conserved. Law of Conservation of Energy

TEMPRATURE

- *The quantitative determination of degree of hotness or coldness of a body may be termed as Temperature.*
- *Also, temperature is a Condition which determines the direction of flow of heat, when two bodies are joined/ mixed together.*



Scales/Units of Temperature

1. Celsius Scale

The melting point of ice at 0 °C (lower fixed-point) and boiling point of water as 100 °C(upper fixed point) at standard atmospheric pressure . Designed by Anders Celsius in 1710

$°C = 5/9\ (°F - 32)$

2. Fahrenheit Scale

The melting point of ice as 32 °F and boiling point of water as 212 °F at standard pressure .Designed by Gabriel Fahrenheit in1717.

$°F = (°C \times 9/5) + 32$

3. Reaumer Scale

The melting point of ice as 0 °R and boiling point of water as 80 °R at standard pressure . Introduced by R,A, Reaumer in 1730

$C/5 = (F - 32)/9 = R/4$

Numerical

What is the temperature for which the reading on Celsius and Fahrenheit scale are same ?

Numerical

What is the temperature for which the reading on Celsius and Fahrenheit scale are same ?

Let x = temperature, which has the same reading on Celsius and Fahrenheit scale

Then, C = F = x

From the relation

C/5 = (F-32)/9

x/5 = (x-32)/9

x = 5(x-32)/9

x = (5x-5*32)/9

9x = 5x-160

9x – 5x = -160

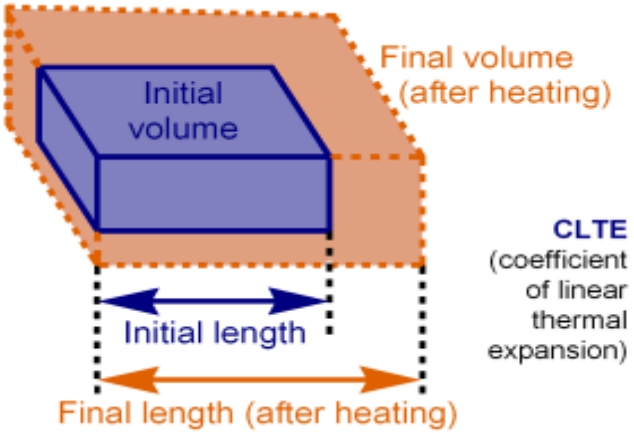
4x = -160

x = -160/4

x = -40°

Thus, -40°C and -40°F represent the same temperature

THERMAL EXPANSION



The phenomenon due to which solid experience a change in its length, volume or area on heating(rise in temperature) is known as Thermal Expansion

Types of Thermal Expansion

There are three types of Thermal Expansion.

1. Linear Expansion
2. Superficial Expansion
3. Volumetric Expansion

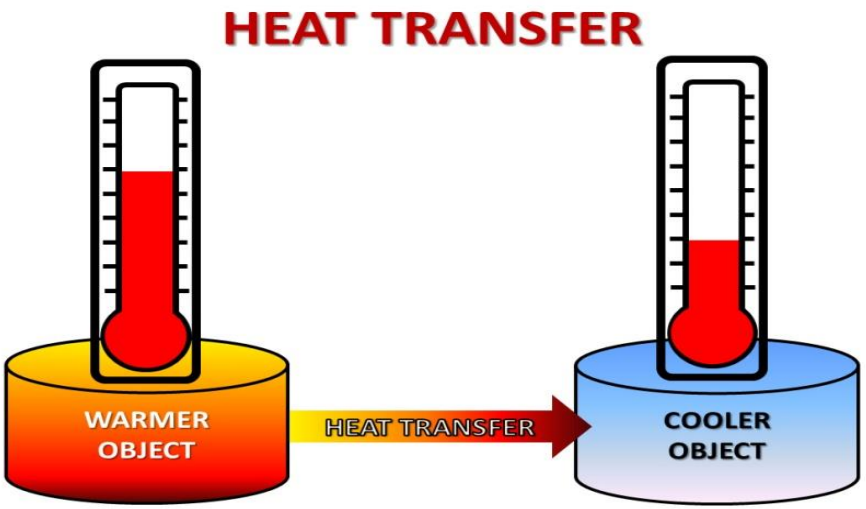
SOME APPLICATIONS OF THERMAL EXPANSION

- In laying a railway line, a small gap is always left between two iron rails
- A glass stopper jammed in the neck of glass bottle can be removed by warming the neck of the bottle
- Some suitable space is left between the girders used for supporting bridges
- Clock pendulum made of Invar, having negligible linear expansion

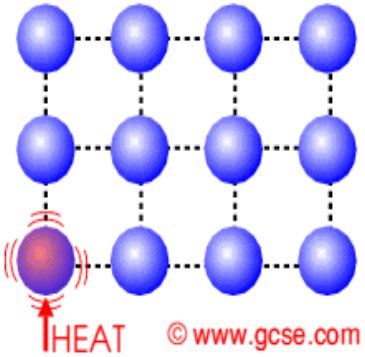
TRANSFER OF HEAT

- Heat energy gets transferred from one point/place to another by different ways/modes
- Modes of Transfer Of Heat-

1. Conduction
2. Convection
3. Radiation



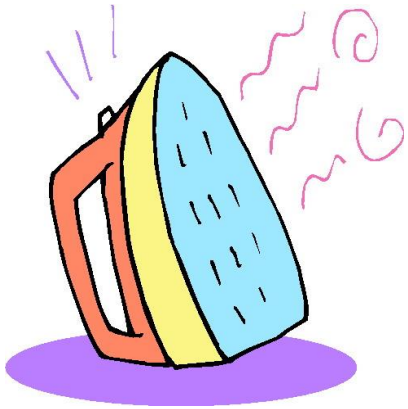
I) CONDUCTION

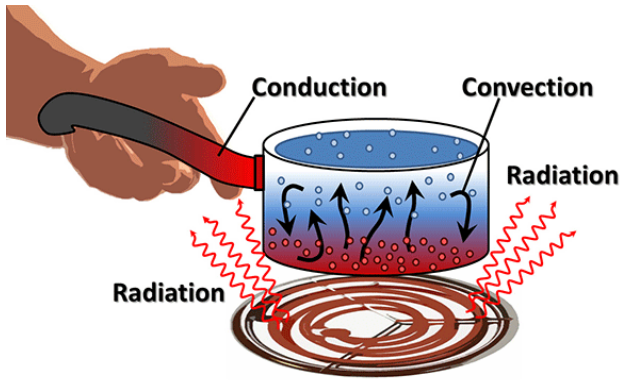


- Heat is transmitted from one point to
- another in the object
- Transmission is in the direction of fall of temperature, without the actual motion of particles of the substance
- Conduction occurs in solids, liquids, and gases.
- Solids transfer energy by the process of conduction only since the molecules in solids are most tightly packed
- Metals in general are good conductors of heat
- Good conductors – Copper, Silver etc.
- Poor conductors – Wood, Glass, Air etc.

Illustrations/Applications of Conduction

- A cube of ice is placed into the hand of a man will melt over time due to heat conducted from the hand .
- When clothes are ironed, heat from the iron is conducted to the cloth, making it easy to iron wrinkles.
- A cold pan placed onto a burner, becomes very hot ,due to the conduction of heat from the burner to the pan.



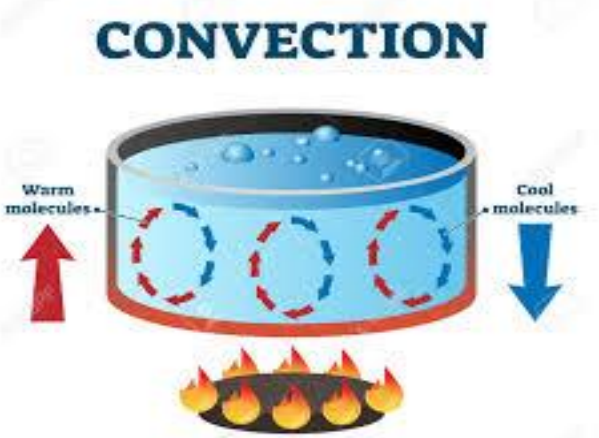


contd…….

- Cooking utensils are provided with wooden handles
- Birds often swell their feathers in winters
- New quilt is warmer than old one
- Ice is packed in gunny bags or saw dust
- Eskimos make double walled houses of the blocks of ice
- Two thin blankets are warmer than a single blanket

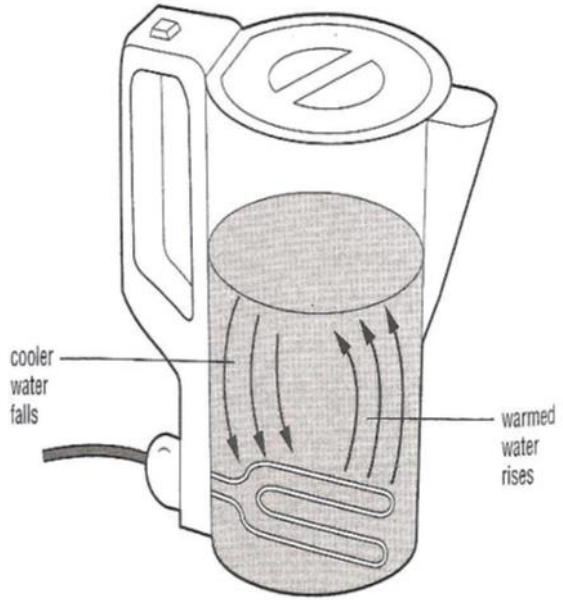
II) CONVECTION

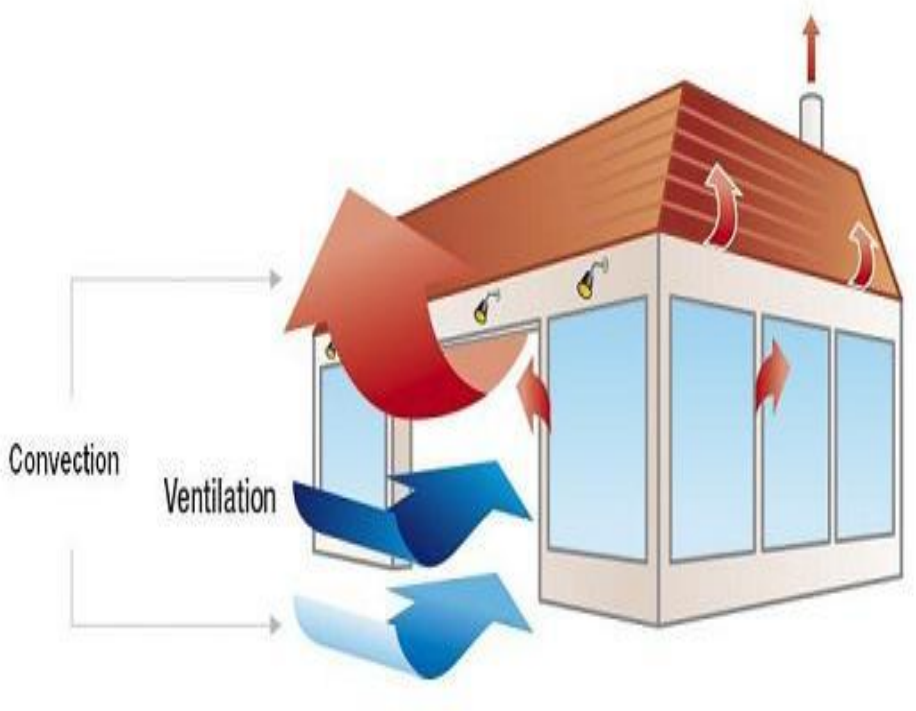
- Heat is transmitted from one point to another, in a substance, due to bodily motion of the heated particles
- The fluids- liquids and gases, are heated by this process
- Heat ⟶ Fluid ⟶ Lighter in Density-Rises upwards
- Colder fluid moves down to take its place
- Currents are set up in the heated fluid – Convection Currents



Illustrations/Applications of Convection

- The heating coil of an electric kettle at the bottom - convection currents
- Heating and cooling systems of the houses
- Ventilation in homes- used to keep rooms cool.

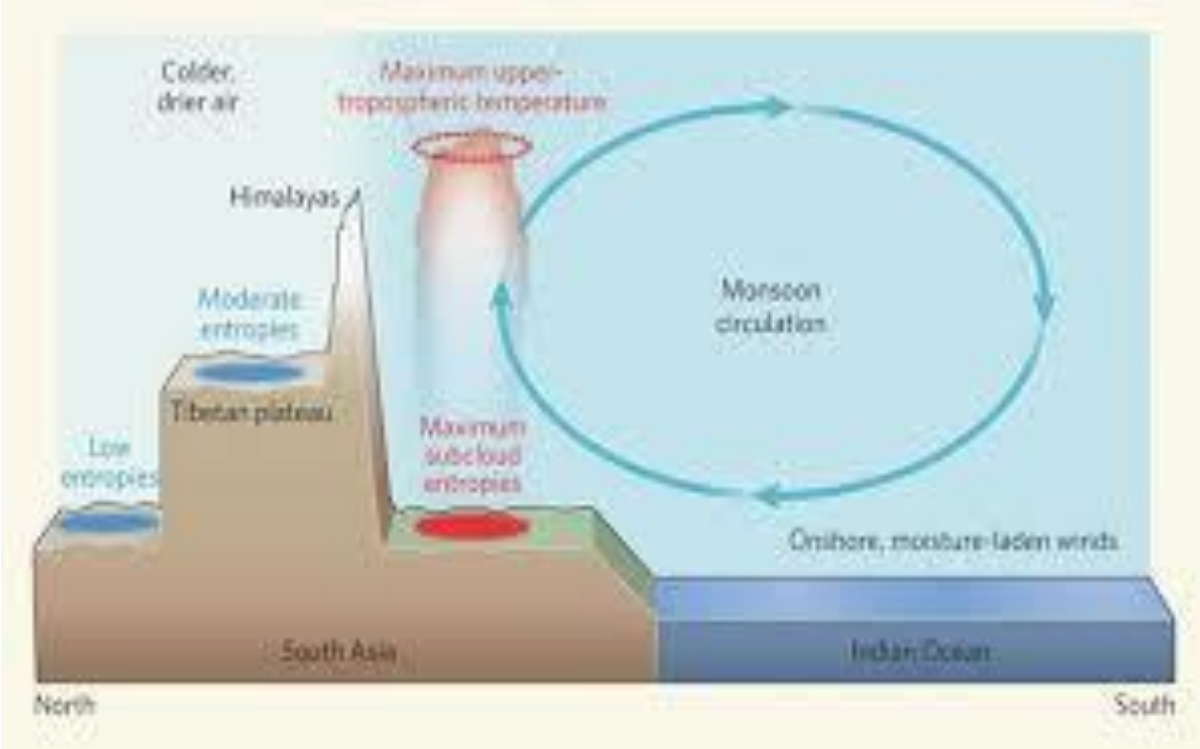




❖Monsoons

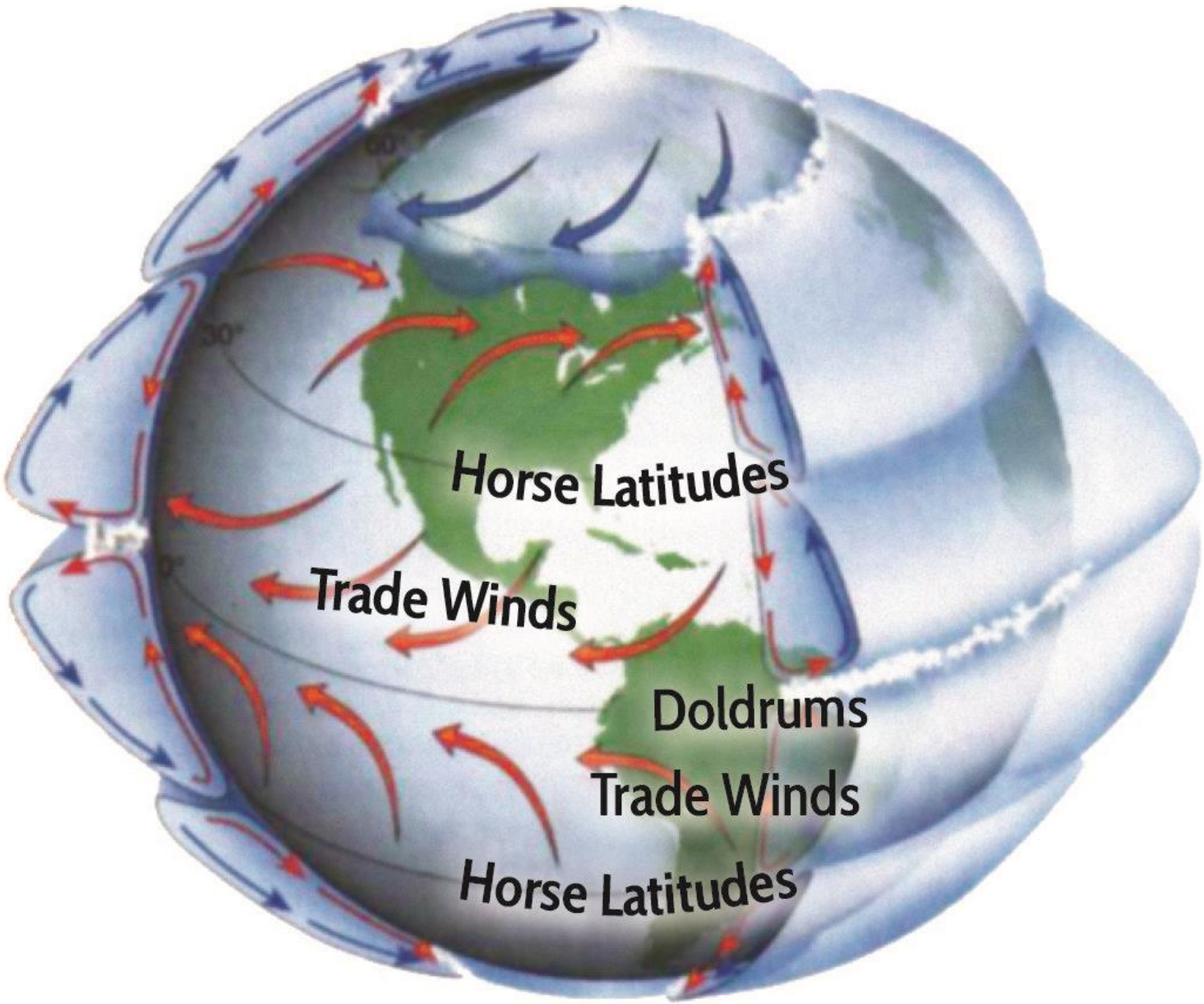
Convection – One of the many causes of monsoons in India

A cycle is set up between the hot air in plains and moisture laden less hot air from the Indian Ocean

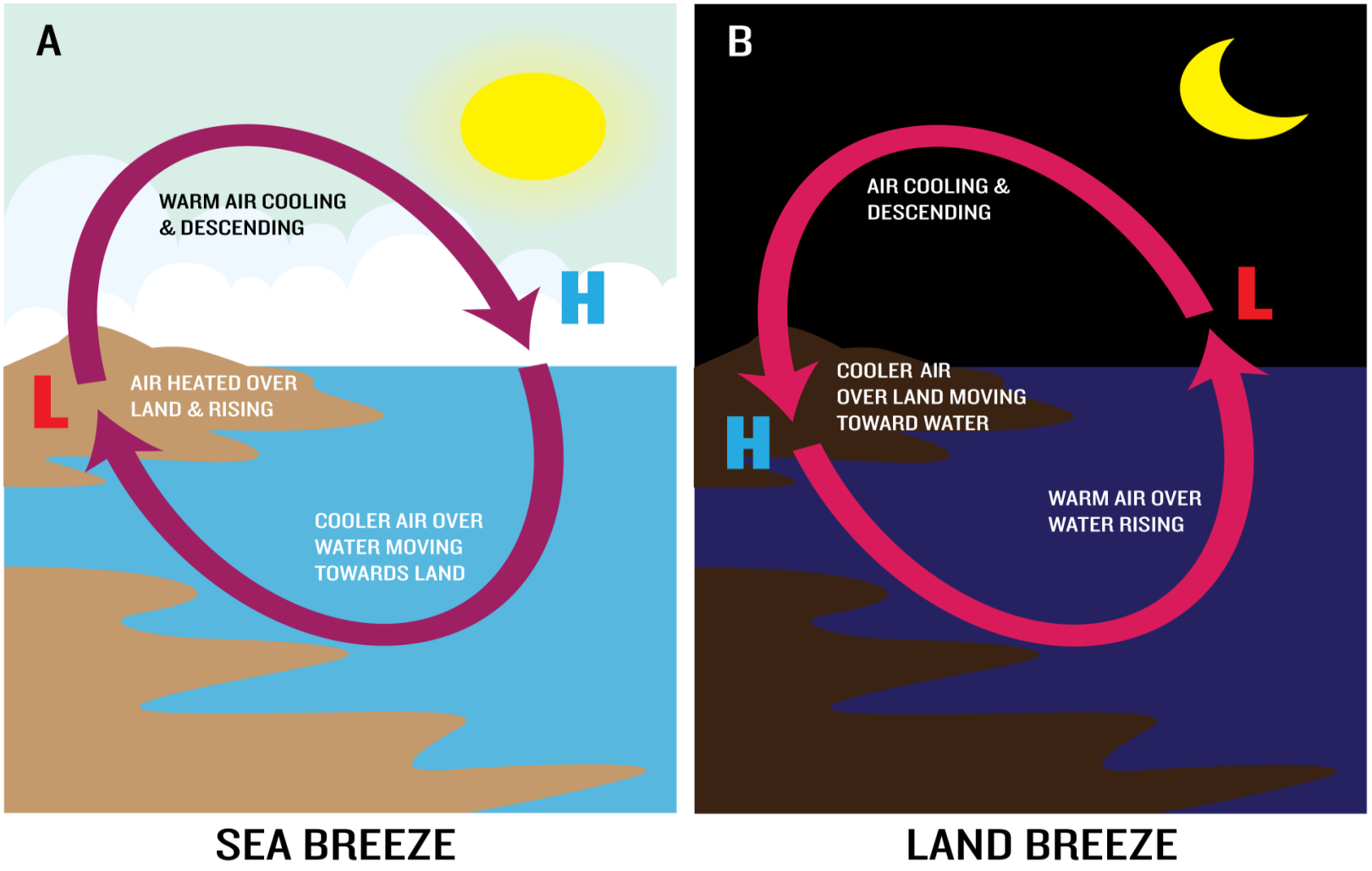


Trade Winds

- Heated Air, in contact with earth's surface near the equator, expands and rises up – rendering equator a region of low pressure
- Extremely cold air in the upper atmosphere comes down, rendering poles a region of high pressure
- Different pressures at poles and equator leads to formation of winds in the atmosphere
- **Anticlockwise Rotation of the earth around its own axis drifts the warm wind from equator to north, towards east**
- This steady wind blowing near the earth's surface from north east to the equator is called **Trade Wind**

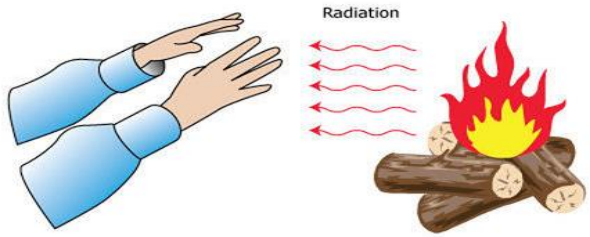

Horse Latitudes
Trade Winds
Doldrums
Trade Winds
Horse Latitudes

- Natural convection currents in land breeze and sea breeze.



III) RADIATION

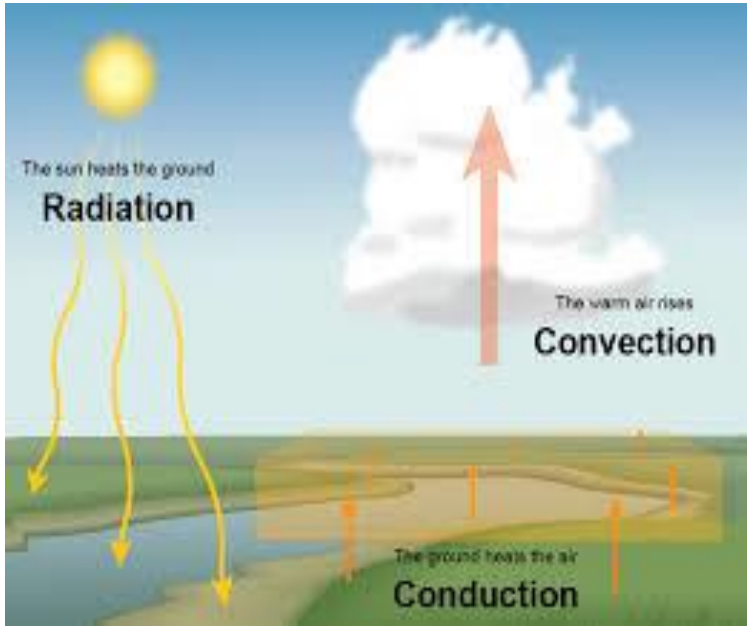
(Heat)

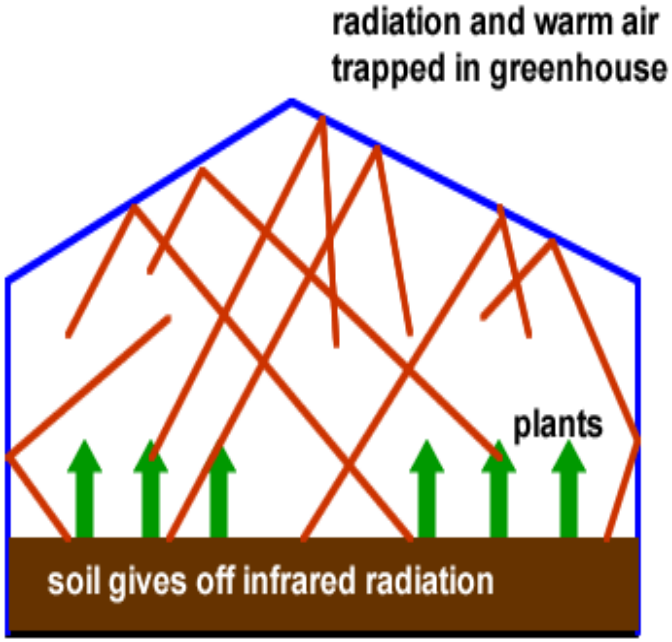


- Heat is transmitted from one place to another without heating the intervening medium.
- Can pass/travel through medium as well as vacuum
- Conduction and convection not possible in vacuum

Illustrations/Applications of Radiation

- Heat radiations from the sun
- Heat from a gas stove
- Heat from burning of wood/coal
- Greenhouse effect





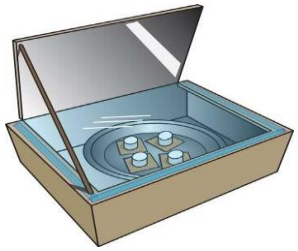
Thermal Radiation/Heat Radiation

- Energy emitted by a body in the form of radiation on account of its temperature
- Wavelength range from $8X10^{-7}$ m to $4X10^{-4}$m
- All objects above 0˚K(0˚K = -273.15˚C) emit thermal radiations continuously
- Energy and wavelength of thermal radiations depend on the temperature and nature of the hot radiating body

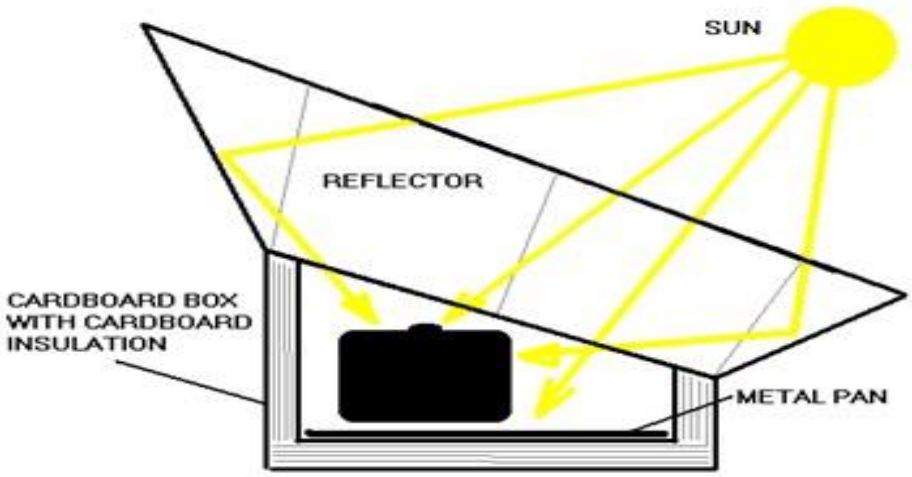
Properties of Thermal Radiation

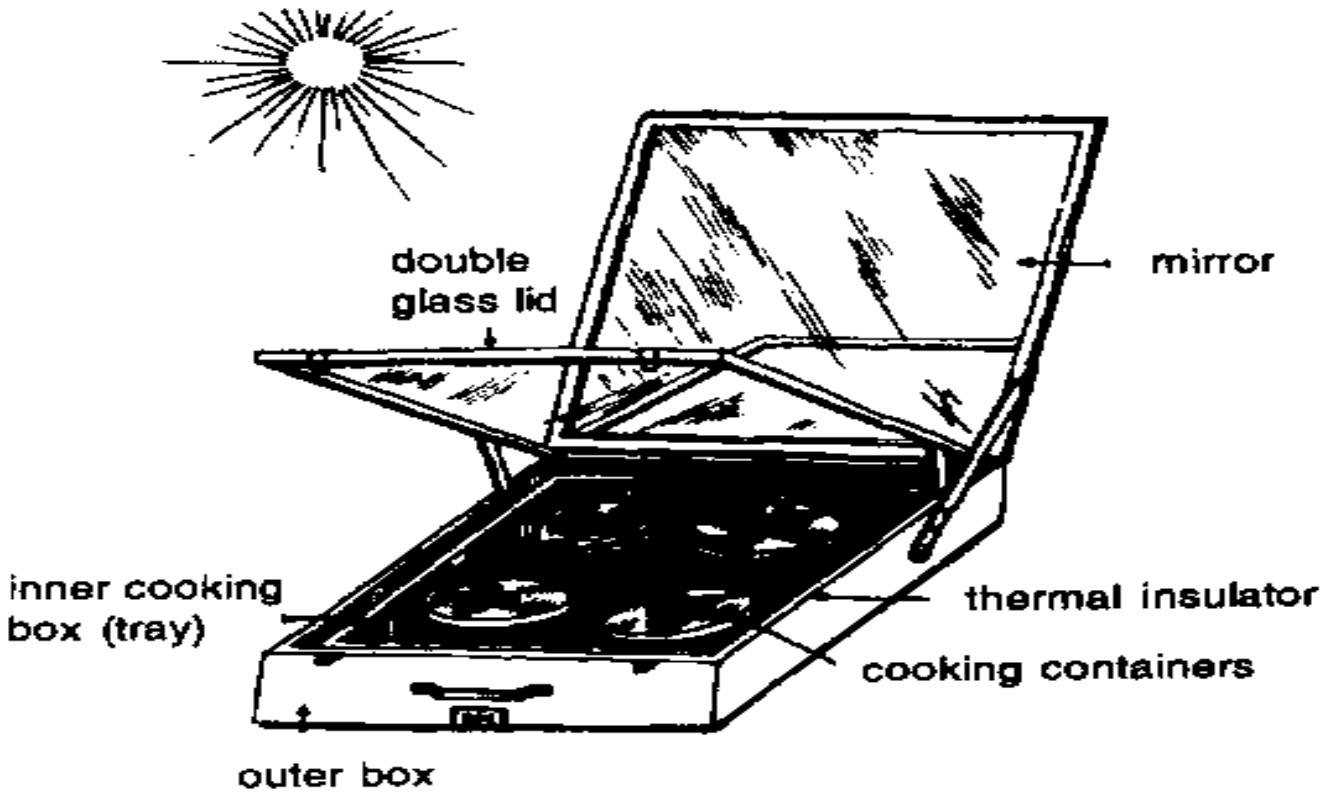
- Can travel through vacuum
- Always travel along straight lines
- Obey the laws of reflection(just as the light)
- Can be refracted
- Do not affect the medium through ehich they pass
- Obey the inverse square law
- Velocity of thermal radiation is equal to the velocity of light

SOLAR COOKER



- The rays of the sun are converted to heat energy that cook the food; and this heat energy is then retained by the pot .
- Solar cooker consists of
  - a darkened or blackened pot with a lid as they heat up more quickly
  - a clear transparent covering such as a large glass bowl or a durable plastic bag for retention of heat to raise the temperatures and preventing the heat from escaping
  - reflecting surface such as mirrors to reflect sunlight to concentrate the suns rays.


SUN
REFLECTOR
CARDBOARD BOX
WITH CARDBOARD
INSULATION
METAL PAN


double
glass lid
mirror
inner cooking
box (tray)
thermal insulator
cooking containers
outer box


THANK YOU