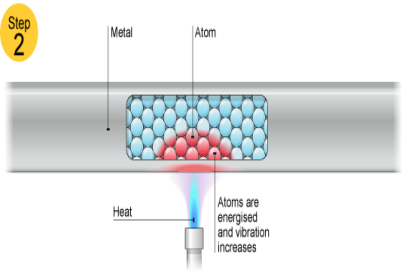
CHAPTER NO:9

Transfer of Heat

Q.1 Define conduction of heat and explain mechanism of heat? Also give a few practical example?

Conduction of heat:-the process by which heat energy is transferred from particle to particle by collision is called conduction of heat.

- Mechanism of heat conduction:- there are two ways by which heat energy is transferred.
  - **i) Vibration of atoms in metals:-**
    A metal consists of large number of atoms which vibrates about their mean position. When heat is supplied to its one end. Then because of this heat the vibration of atoms increases. These atoms collide with their neighbor atoms and transfer their he3at to neighboring atom and by this way heat is transferred to the other end.



  - ii) Motion of free electron in metal:-
  - iii) We know that a metal consists of free electron which can carry heat from one point to another end. When heat is supplied to metal rod. It's K>E o atoms increases. They transfer their heat to the free electrons by collision and these free electrons transfer their heat to other free electron and thus heat is transferred to the other end.
- **Practical application heat conduction:-**
  - i. We use met5al pots for cooking which transfer the heat easily to the food placed in side them.
  - ii. Plastic foams and fiberglass are bad thermal conductors. They are used in the wales and ceiling of homes. And keep them warm in winter.
  - iii. Woolen clothes have fine pores which contain air. The air and wall are bad thermal conductor. Thus they avoid the flow of heat from our body to the surrounding and keep us warm in winter.

Q.2 Describe conduction of heat in solid, liquid and gas?

Ans. **Conduction in solids:-**usually metallic solid are good conductors of heat. Which contains free electrons and packed atoms and they play very important role in conduction of heat which can carry heat energy inside a metal from one point to another point. And they

are considered god conductors while plastic wood and rubber etcare poor solid conductor because they have no free electron.

Conduction in liquid:-liquids are mostly poor conductor of heat as compare to metallic solids because the inter molecular distance is larger in liquids than solids. Therefore the rate of conductivity is also smaller than solid.

Conduction in gases:- there is a large distance among gas molecules. Thus the rate of conductive collision in gas is very smalls as compare to solids and liquids thus gases are the poorest conductors of heat. The conductivity of air is of waters 20 times smaller than that of water.

Q.3 state and explain thermal conductivity?

Thermal conductivity:- The measure of ability of a substance to conduct heat energy is called thermal conductivity (OR) the amount of heat flowing through a unit area of a substance in one second having a temperature difference of 1k across at a length of one meter is called thermal conductivity.

Explanation:-consider a rod of length "L" having area of cross section "A" and difference of temperature ΔT then the amount of heat "Q" supplied depends upon the following factors.

i) "Q" is directly proportional to area of cross section "A"
Q φ A……..i
"Q" is directly proportional to change in temperature ΔT
ΔT $\varphi \Delta T$……ii
"Q" is directly proportional to time "t"
Q φ t ……iii
Q is inversely proportional to length "L" of rod
Q φ 1/L……iv
Combining eq (i),(ii), (iii), we get.
Q φ A. ΔT .t 1/L
Q ΔT A . ΔT t/L
Q = k A ΔT t/L……..v

Where "K" is constant of proportionality and called thermal conductivity of a substance. It's value depends upon nature material and its unit is J/k. m .sec.

Q.4 Define convection heat and explain its mechanism?

Convection of heat:-The transfer of heat fro one place to another by the actual motion of the heated particles is called convection of heat. (OR) the process in which heat is transferred from one place to another due to transfer of molecules is called convent of heat.

Mechanism of heat convection:-the mechanism of the convection of heat con be explained by the behavior of medium b/w hot and cold objects. Convection occurs only is fluids (liquids

ei gases) and not in solids because the molecules of solids are tightly bounded with each other. And they can easily move from on place to other place in a body.

Consider a beaker filled with water and a few crystals of potassium per magnate are also dropped in it. When heat is given to beaker. Potassium per magnate dissolve in water and du4e to which the water of bottom becomes colourd. After sometime colourd water will rise to the top which shows that water molecule moved form bottom to upper pat because they become less dense due to heat so, hot Particle's or molecules move upward while cold molecules move downward. And the hot molecules transfer heat to the surface and the transfer of heat by this way is known as convection of heat.

Q.5 Give some practical examples of heat convection?

Ans. Heating water:-when heat is supplied to a kettle filled with water. Then the bottom layer of water becomes heated and these layers are less denser than water at bottom so these hot layers move upward while the cold layers move downward. This process is continued unless the whole water becomes heated.

Ventilation:-During the construction of houses ventilators are installed in rooms. The warm and stale air is less denser. So it rises up and go out through ventilators. By this way fresh air comes inside the room through door, windows and ventilators while the warm air goes out and keeps the room at moderate temperature.

Refrigerator:- convection used in refrigerator on where the layers of air is cooled by freezer compartments. This cold air moves downward and the warm air at the bottom rises to the top. This process continues and after some time the whole environment inside the refrigerator becomes cold which keep the food items in safe condition.

Riding on thermals:- thermal are streams of hot air which arises from the sun the gliders airplanes are able to arise by riding on the thermals the birds can also fly in thermals with flopping their wings.

Q.6 what is radiation of heat and explain its mechanism? Also give a few practical applications?

Ans. Radiation of heat:-the process by which heat is transferred from one place to another with or without any material medium is called radiation of heat.

Mechanism of heat radiations:-transfer of heat from one place to another place because of convection and conduction require a material medium. While in case of transfer of heat by radiation does not need a material medium.

the mechanism waves. Radiations can transfer energy through vacuum and also through certain material medium like glass the mechanism of heat radiation is electromagnetic phenomenon and not molecular motion. The heat energy from sun passes through vacuum and reaches us by radiation.

Practical application of heat radiations:-

i. In summer seasons, we often give a coat of white colour to the upper surface of the roof of our room.it is because the white colour reflects most of sun radiation. and thus the room remains at moderate temperature.

ii. We wear light colour cloth because, light colour cloth absorb minimum radiations and maximum radiations. Thus we feel cooling effect.
While in winter seasons, we wear dark colourd clothes absorbs maximum sun radiations and thus keep our body warm.

iii. Greenhouse effect is another application of heat radiation during the day the sun radiations enters green house and is absorbed by the soil and plants inside the green house. At night, the energy radiated by the soil cannot go out f the green house and thus keep house warm. As a result, the plant growth rate increases.

Q.7 what are thermal radiations also explain good and bad absorbers?

Thermal radiations:-the radiations which are emitted by a body due to its temperature is called thermal radiations.

Explanation:-All bodies weather cold or hot can radiate heat. A hotter body radiates more heat than on identical colder body. At constant temperature a body from surrounding radiates as much heat to its surroundings as it absorb thermal radiations can be radiated from a body at all temperature. How ever at high temperature3 a body radiates more radiation. The radiation which are less energetic than light are called infrared radiation while the radiation which are more energetic than light are called ultraviolet radiations. The heat which we receive from a hotter object is mostly in the form of infrared radiations. Good and bad absorbers:- the body which absorbs all radiation or maximum radiations are called good. Absorber while the body which absorbs minimum radiations are called bad absorber

A dull black kettle absorbs heat better than a polished silvered kettle. So a black kettle is a good absorber than polished silvery kettle. A silvery mirror like surfaces reflects all radiations falls upon it. So, such surfaces are called bad or poorest absorbers.

We wear often white clothes in hot seasons because white cloths are good reflectors and poor absorbers. While in winter season we wear dark color cloths. Because they are good absorbers and bad reflectors.

Q.8 discusses global warming How is it a threat to human life?

Ans. The earth's surface receive radiation from sum. The temperature of earth is about look and that of earth is about 300k.

The sun emits radiation of very high frequency like ultraviolet rays because its temperature is very high while the earth emits low frequency radiation because its is low as compare to sun these low frequency radiation are absorbed by water and co2 which are present in the atmosphere of earth the atmosphere of earth radiates back most of its energy to earth. As a result the temperature of earth increases. The earth's globe warms gradually this type of effect which gives rise to global warming is called green house effect the amount of co2 in earth atmosphere increases day by day due to fumes coming form factories and vehicles. Due to co2 the global warming increases with the passage of time if this process is continue then a stage will come that everybody will become hot. There will be no cold body on earth's

surface. The disorder will reach to it's peak energy wil not be available for useful work. every living thing will face certain death which is called heat death universes. So, global warming is a great threat to human life.

Q.9 Discuss the green house effect How this effect keep the green house warm?

Green house effect:-The warming of on enclosure such as green house due to selective absorption of radiations such as green house due to selective absorption of radiations by the boundary of the Endo sure is called green house.

Explanation:- we can use glass green house for warming purposes the high frequency sun's radiation pass through the glass and absorbed by soil and plants inside the Endo sure as the soil is at low temperature as compare to sum so the soil and plants emits low frequency radiations at night. These low frequency radiations can not pass through glass and absorbed in it.

The glass emits some of these radiations back toward soil and plants. In this way warming effect is produced in the Endo sure which is known as green house effect.

CONCEPTUAL QUESTION

Q.1 why a wire=gauze is often placed over a burning flame for heating on object?

Ans. A wire gauze is often placed over a burning flame for heating a object. Because wire gauze conducts heat outward form flame a glass beaker can be heated safely o wire gauze because it protects the beaker from the contracted heat of the flame.

Q.2 Give three ways in which insulating material can be used to reduce head losses from a houses?

Ans.

i) use air filled cavity walls instead of solid bricks walls.
ii) In roof a layer of insulating material like plastic can be used to reduced heat conduction.
iii) Houses with small windows and doors will loss small amount of heat energy.

Q.3 see for ans Q8 page 72 we wear often white clothes.

Q.4 why is the freezer compartment kept at the top refrigerator?

Ans. The freezer compartment of a refrigerator is kept at top because it cools the air of surrounding and makes it denser compare to the air of bottom the cool air moves downward while warmer air moves upward, where it is cooled.

Q.5 why does thermal radiations pass more easily into a green house than out of it?

Ans. The heat is transmitted into a green house in the form of high frequency from sun these radiation are eraitted back inside the green house in the form of low frequency. Which cannot escaped from a glass block and are trapped inside.

Q.6 How heat losses are reduced in a thermos flask?

Ans. a thermos flask consists of doubled walled glass vessel silvered on the inner side. The silvered surface reflects back all radiant heat trying to leave vessel by radiations. The space b/w two walls is highly evacuated to prevent convection. The glass being a poor conductor, minimize the conduction of heat.

Q.7 How the interior of a car parked in the hot sum warms easily?

Ans. Heat is transmitted into a car in the form of high frequency from sun these are reflected inside and losses some energy and appears as low frequency radiation which cannot escaped car and are trapped back.

Q.8 A black car, standing in the sun warms up more quickly than any other why?

Ans. A black car standing in the sun warms up more quickly than any other because the black surface is a good absorber of heat radiator than any other surface.

Q.9How air filled cavity walls keep a hose warmer in winter than a solid brick wall?

Ans. the air is a bad conductor of heat so an air filled wall keep a house warmer because

It stops the flow of heat from hose to outside. It stops the flow of heat from house to outside.

Q.10 why a tile floor feels colder to bare feet than carpeted floor?

Ans. A carpet is bad conductor of heat as compare to tile floor when a bore foot is put on the floor more heat is lost by the foot which is absorbed by tile floor and as a result we feel cool. If we put the foot on carpet floor we feel less cool because tile in this case our feet losses no heat that' why a floor feels colder to bare feet then a carpet floor.

Q.11 See for ans Q1 page 69.

NUMERICAL PROBLEMS

1. **window glass has thermal conductivity of 0.08 $wm^{-1}k^{-1}$calculate the rate at which heat is conducted through a window of are 2.0m^2 and thickness 4.0mm. the temperature insid4e on air conditioned room is 20°c the out doors temperature is 35°c.**

   Solution:- thermal conductivity = k = 0.8w/mk A = $2m^L$

   Thickness of windows = L = 4mm = 4 x 10^{-3}m

   T_1 = 20°C T_2= 35°c rate of change of conduction = Q/t

   Q/t =?

   We know that Q = K.A $\Delta T.\, t./L$

   ⇨ Q/t = K.A $\Delta T.\, t./L$

   ⇨ Q/t = 0.8 x 2 x (35 -20)/4 x 10^{-3}

   ⇨ Q/t =

   ⇨ 1.6 x 15 x 10^3 /4

   ⇨ Q/t =

   ⇨ 0.4 x 15 x 10^3

   ⇨ Q/t = 6.0 x 10^3

   Q/t = 6 x 10^3

2. **one end of a metallic rod of cross sectional are 90nn^2**and thermal conductivity 0.32 kw m^{-1} k^{-1} is kept at hight temperature. When steady condition is staid. The temperature gradient from one end to the there is 4.6 x 10^2 km^{-1} calculate rate of flow of heat only rod.

   Solution:-Area = 90mm^2= 90 x $(10^{-3})^2m^2$ = 90 x 10^{-6} m^2

   Thermal conductivity = k= 0.32 kw /m.k = 0.32 x 10^3 w/m.k

   Temperature gradient = $\frac{\Delta T}{L} = 4.6\ x\ 102\frac{k}{m}$

   Rate of flow of heat = Q/T = ?

   We know that Q = k. A$\Delta T.\, T/L$

   ➢ Q/t = kA .$\Delta T/L$

   ➢ Q/t = 0.32 x 10^3 x 90 x 10^{-6} x 4.6 x 10^2

   ➢ Q/t = 0.32 x 90 x 4.6 x $10^{3\ -6\ +2}$

   ➢ Q/t = 132.48 x 10^{-6+5}

   ➢ Q/t 132.5 x 10^{-1}

   ➢ Q/t = 13.25 walt

3. The external wall of a brick hose has on area of 16m^2 and thickness of 0.3m. the temperature inside and outside the house are respectively 20°C ε O°C calculate the rate of heat lass thought the walls.

   Solution:- area =A= 16m^2 thickness = L = 0.3m

   T_1 = 20°C T_2 = O°C ΔT = $T^2 - T_1$ ΔT = 20 – 0 = 20°c

Thermal conductivity of to concreter = k = 0.5 w/k.m

Rate of heat loss = Q.t

As Q. k.A $\Delta T\ t/L$

- Q/t = k.A ΔT/L
- Q.t = 0.5 x 10 x 20 /0.3
- Q/t = 533T/sec or walt

4. Two vessels of different metals are similar in shape and size they are fully filled with ice at o- O°C by the heat from outside all the ice in one vessel melts in 25 mile and that in other verse lie 20 mints compare there thermal conductivities?

   Solution:-

   $A_1 = A_2 = A$, $L_1 = L_2 = L$ because both vessels are same in shape and size.

   T_1 = 25min = 25 x 60 = 1500sec

   T_2 = 20min = 20 x 60 = 1200sec

   Ratio of thermal conductivities = k_1/k_2 =?

   As we know that:- Q = k . A ΔT.t/L

   ⇨ K = QL/A$\Delta T.\ t$

   K_1 = QL/$A_1\ \Delta L\ t_1$.....k_2 = QL/$A_2 \Delta L\ t_2$

   Now => $k_{1/}$ = ~~QL~~/A$\Delta L\ t1/$

   k_2 ~~QL/AΔL~~ t_2

   ⇨ $K_1/k_2 = t_1/t_2 = {}^{4}\cancel{1200}/_{5}1500 = 4/5$ =>

   $k_1/k_2 = 0.8$

5. A Houses losses a lot of heat through a window. Calculate the rate of flow through a glass window area of a 0.3m^2 and thickness 3.2 mm the temperature at the inner and outs surface are respectively 15.0^{0}C and – 5 ^{0}C.

   Solution:- Area = A = 3m^2

   Thickness = L = 3.2mm = 3.2 x 10^{-3}

   T_1 = 15°c T_2 = - 5°c ΔT = 15 – (-5) = 15 +5 => $\Delta T = 20$ °c

   K = 0.8 w/k.m

   Rate of flow of heat = Q/t = ?

   As we know that:

⇨ Q = k. ΔT.A.t/L

⇨ Q/t = k. ΔT .A./L

⇨ Q/t = 0.8 x 20 x 3/ 3.2 x 10^{-3}

⇨ Q/t = 0.8 x 20 x 3 x 10^3

3.2

- ⇨ Q/t = $\frac{48}{3.2}$ x 10^3
- ⇨ Q/t = 15 x 10^3 walt => Q/t = (5k walt