3 HEAT

INTRODUCTION :

Heat is a form of energy. We know that energy means capacity to do work. So we can say, heat, being a form of energy, can do work. For example, when pressure cooker is heated, steam is formed within the cooker and this steam can lift the lid of the pressure cooker. In this chapter we shall study about the meaning of hot and cold and how things are heated or cooled.

TEMPERATURE - DEGREE OF HOTNESS OR COLDNESS :

When we touch an ice cube, we say it is cold. Similarly when we touch a cup of tea, we say it is hot. Here we compare the hotness or coldness of an object with that of our hand. But sensing the hotness or coldness by touching is not always true. "The degree of hotness or coldness of a substance is called its temperature." When two objects at different temperatures are kept in contact, heat flows from hotter object (high temperature) to colder object (low temperature). So direction of heat flow is governed by the temperatures of the objects in contact. It should be kept in mind that exchange of heat continues so long as the temperatures of the two objects remains unequal. Heat flow stops as soon as temperatures become equal which is known as thermal equilibrium.

DIFFERENCES BETWEEN HEAT AND TEMPERATURE :

Heat	Temperature
(i) Heat is a form of energy, which causes the sensation of hotness or coldness.	(i) The degree of hotness or coldness of a body is measured in temperature.
(ii) Heat energy is the cause.	(ii) Temperature is the effect.
(iii) It is measured in joule or calorie.	(iii) It is measured in Kelvin, or Celsius or Fahrenheit.
(iv) Calorimeter is used to measure heat energy.	(iv) Thermometer is used to measure temperature.
(v) Heat energy always flows from body at high temperature to body at low temperature.	(v) Temperature depends on the average kinetic energy of the molecules.

MEASUREMENT OF TEMPERATURE :

Temperature is measured by an instrument called thermometer.

A simple thermometer has a long, narrow, uniform glass tube at one end of which there is a glass bulb filled with mercury.

Along the length of the glass tube, there are graduations (Scales) made on the basis of two standard temperatures. These are called lower fixed point and upper fixed point.

Lower fixed point is the temperature at which ice melts and upper fixed point is the temperature at which water boils.

There are two commonly used temperature scales

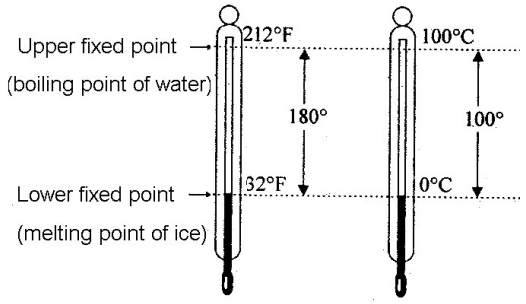
(i) Celsius Scale (ii) Fahrenheit scale (iii) Kelvin Scale

(a) Celsius or Centigrade Scale :

As the name suggests, this scale has **100 divisions** between the upper and lower standard points. This scale was introduced by a Swedish astronomer Celsius and is known after his name. Each division on this scale is called one degree centigrade or one degree Celsius and is written as ^{0}**C**. More sensitive thermometers have **200 divisions** between standard points and each division is equal to ½ ^{0}**C**. Sometimes these thermometers are called **half** ^{0}**C** thermometers.

(b) Fahrenheit Scale :

This scale was introduced by Fahrenheit. On this scale **32^0 F** represents the melting point of ice and **212^0 F** the steam point. Zero is marked **32^0 F** below the ice point. The length in between the standard points is divided into **180** equal parts. Each division on this scale is called **1^0 F**. This scale is widely used for meteorological and clinical purposes.



Relation between Celsius and Fahrenheit scales :

(i) $\boxed{\frac{C}{5} = \frac{F-32}{9}}$

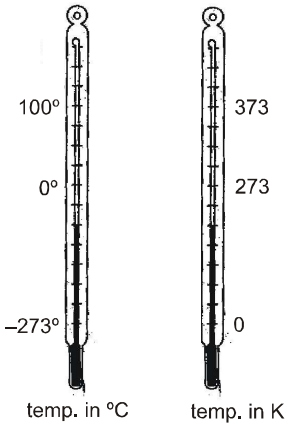
Where C and F are the corresponding temperatures shown on the scales of thermometers in Celsius and Fahrenheit units respectively.

(ii) 1° difference of temperature on Celsius scale $= \left(\frac{9}{5}\right)^{\circ}$ difference of temperature on Fahrenheit scale

(c) Kelvin Scale :

The scale of measurement of temperature, in which lowest temperature is **zero Kelvin** (**–273^0 C**) is called

Kelvin scale. This is also called S.I. scale of temperature.



temp in kelvin = 273.15 + temp in °C
(T) K = 273.15 + (t) in °C

- **Characteristics of Kelvin scale :**

  (i) There cannot be any temperature below zero Kelvin.

  (ii) The temperature is expressed in (**K**), but no degree symbol is attached to it.

  (iii) Rise in temperature in kelvin = Rise in temperature in **degree Celsius.**

Note : ***Conversion of temperature from Kelvin scale to Celsius scale is K = (C + 273)***

- **Relation between different temperature scales :**

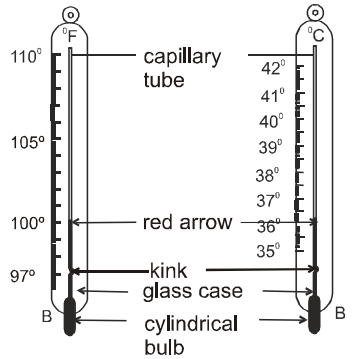
$$\frac{C}{5} = \frac{F-32}{9} = \frac{K-273}{5}$$

Type of Thermometer :

(a) Clinical thermometer :

It is a specially adapted Fahrenheit thermometer used by doctors to record the temperature of human body.

The markings are from 95^0 **F** to 110^0 **F**, because the temperature of human body does not fall below 95^0 **F** or rise above 110^0 **F**, as in either case death occurs. Some clinical thermometers have centigrade scale, marked between 35^0 **C** to 43^0 **C**, the normal temperature of human body being 37^0 **C**. Before using the thermometer it should be washed with water and then jerked so that the mercury flows back into the bulb.



(a) marked in °F (b) marked in °C

(b) Laboratory Thermometer :

Different types of thermometers are used for different purposes. The maximum and minimum temperatures of the previous day, reported in weather reports, are measured by a thermometer called the maximum-minimum thermometer. The range of a laboratory thermometer is generally from –10ºC to 110ºC.

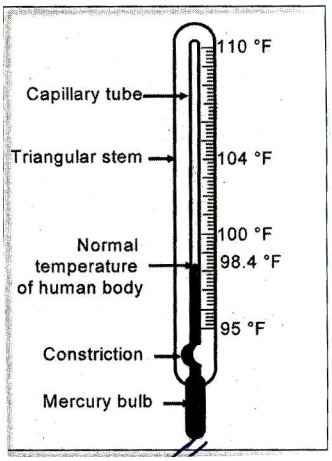
In addition to the precautions needed while reading a clinical thermometer, the laboratory thermometer

- Should be kept upright not tilted.
- Bulb should be surrounded from all sides by the substance of which the temperature is to be measured.
- Bulb should not touch the surface of the container.

***[Note:-*In clinical (Doctor's) thermometer, Fahrenheit scale is used.**
In laboratory thermometer, Celsius scale in used.
SI unit of temperature is kelvin (K)]

Working of Thermometer :

When the Thermometer bulb is in contact with a hot object, mercury column rises up through the capillary tube. The tip of the mercury column in the capillary shows the temperature of the object.



Clinical thermometer is used to measure the temperature of human body.

Clinical thermometers have a kink in the capillary tube. This kink prevents the mercury column to fall down as soon as the thermometer is taken out from the patient's mouth.

The normal body temperature is 98.6°F (is 37°C). The range of temperature is clinical thermometer is from 94° F to 108°F (35° C to 42° C).

The range of a laboratory thermometer is from –10° C to 110° C

Ex.1 At what temperature, if any, do the following pairs of scales give the same reading :
(a) Celsius and Fahrenheit,
(b) Fahrenheit and Kelvin and
(c) Kelvin and Celsius ?

Sol. If the temperature is q at which the reading of two scales coincides, then from

$$\frac{T_C - 0}{100} = \frac{T_F - 32}{180} = \frac{T_K - 273.15}{100}$$

(a) $\frac{\theta}{100} = \frac{\theta - 32}{180}$, i.e., $q = -40$

i.e., reading of Celsius and Fahrenheit scale coincides at –40°.

(b) $\frac{\theta - 32}{180} = \frac{\theta - 273.15}{100}$, i.e., $q = 574.6$

i.e., reading of Fahrenheit and Kelvin scale coincides at 574.6°.

(c) $\frac{\theta - 273}{100} = \frac{\theta}{100}$ which is not possible

So reading of Celsius and Kelvin scale can never coincide.

Ex.2 Find the value of 5ºC in ºF and K scale respectively.

Sol. Relation between Celsius and Fahrenheit scale $\frac{C}{5} = \frac{F-32}{9}$

So corresponding value of 5ºC in Fahrenheit scale is $\frac{5}{5} = \frac{F-32}{9} \quad \Rightarrow \quad F = 41^{\circ}F$

Relation between Celsius and Kelvin scale
T(K) = T(ºC) + 273 = 5 + 273 = 278 K

Role of Temperature in Transfer of Heat Energy :

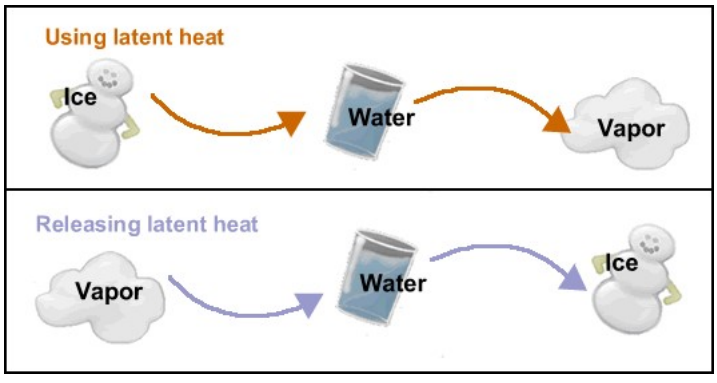
When two bodies of different temperatures are brought in contact with each other, the heat energy always flows from a body at higher temperature to a body at lower temperature, till the temperatures equalise. Thus, it is the temperature of a body which determines the direction of flow of heat energy.

Units of Heat Energy :

Heat energy is measured in calories.
The quantity of heat energy required to raise the temperature of 1 g of pure water through 1 ^{0}C (14.5^{0}C to 15.5^{0}C) is called one calorie.
The calorie is a very small unit of heat energy used for practical purposes. Thus, a bigger unit called kilocalorie is used.
The quantity of heat energy required to raise the temperature of **1 kg** of pure water through **1 ^{0}C** is called one kilocalorie. **1 kilocalorie = 1000 calories.**
Kilocalorie is sometimes called Big calorie or Doctor's calorie or **Calorie** (with capital **C**). The energy value of the foods and the fuel is measured in kilocalories.
We know energy is measured in Joules. As heat energy is a form of energy, therefore, it should also be measured in Joules, rather than calories or kilocalories, for strict scientific purpose. However, doctors still continue with kilocalories.
Following are the equivalent of calorie and kilocalorie in joules :
(i) 1 calorie = 4.186 J = 4.2 J (approx)
(ii) 1 Kilocalorie = 4186 J = 4200 J (approx.)

EFFECTS OF HEAT :

(i) Temperature increases when heat is gained by an object.
(ii) Similarly, when an object is cooled (i.e. heat is taken out), its temperature decreases.
(iii) Heat causes expansion (in length, area, volume etc.) of an object
(iv) Heat causes change of state.



APPLICATIONS OF EXPANSION OF SOLIDS :

1. Fixing of iron rim on wooden cart wheels.
2. Riveting of metal plates.
3. A small gap is left while laying rail tracks.
4. Girders are mounted on the rollers by leaving small space.
5. A sag is left, while laying telephone and electric lines.
6. A small gap is left between the blocks, while laying the concrete roads.
7. Special glasses like borosil or pyrex glasses are used to avoid the breaking of ordinary glass, when hot water is poured.

THE BIMETALLIC STRIP :

A bimetallic strip is made up of two different metals joined together by riveting. Take a brass and an Invar strip of the same size. Rivet them firmly together as shown in the Fig (a). This is called a bimetallic strip. The principle involved is the unequal expansion and contraction of different materials on heating.

When heated brass expands more and its greater length puts it on the outside of the curve as shown in the Fig.(b).

When it is cooled brass contracts more and its shorter length puts it on the inside of the curve as shown in Fig .(c).

Bimetallic strips are used in fire alarms, thermal switches such as those used in refrigerators, bimetallic thermometer etc.

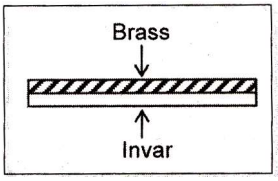


Fig.(a)

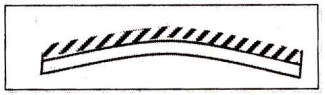


Fig.(b)

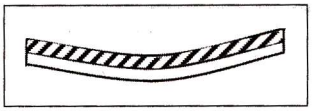


Fig.(c)

SPECIFIC HEAT CAPACITY / SPECIFIC HEAT :

The amount of heat energy required to raise the temperature of unit mass of a substance through **1°C** or **1 K** is called specific heat capacity.

SPECIFIC HEAT OF WATER :

We have already defined specific heat of a substance. On the same basis, we define specific heat of water as the amount of heat energy required to raise the temperature of unit mass (say, one gram) of water through unit degree (1ºC).

specific heat of water,

$s = 1$ cal g^{-1} $ºC^{-1} = 1$ cal g^{-1} K^{-1}

$s = 4.2$ J g^{-1} $K^{-1} = 4200$ J kg^{-1} K^{-1}

Specific heat of a substance depends also on the state of the substance i.e. solid, liquid or gas.

Eg.: Specific heat of ice = 0.5 cal g^{-1} $ºC^{-1}$;

specific heat of water = 1 cal g^{-1} $ºC^{-1}$ and

specific heat of steam = 0.47 cal g^{-1} $ºC^{-1}$.

ANOMALOUS EXPANSION OF WATER :

Generally matter expands on heating and contracts on cooling. But water shows a peculiar behaviour. When water at 0°C is heated, it contracts and its volume decreases from 0 °C to 4 °C. At 4 °C water has minimum volume and maximum density. From 4°C onwards, as temperature increases, the volume also increases. This behaviour of water is known as anomalous expansion of water.

The temperature of water near the cooling mixture decreases and density increases .When the temperature fall to 4 °C density becomes maximum. Then the water in the central part goes to the lower portion, the lower thermometer shows 4 °C and it remains constant. Now the temperature of water in the central portion decreases to 0 °C, it moves to upper portion.The upper thermometer shows the reading as 0 °C and slowly it freezes to form a thin layer of ice. But the temperature of water in the lower portion shows 4 °C.

Because of this behaviour of water, aquatic life can survive in frozen ponds in the cold countries

QUANTITY OF HEAT GIVEN TO (OR TAKEN FROM) AN OBJECT :

The heat given to (or taken from) an object depends on the following factors:

(i) Mass of the object (m)

(ii) Change in temperature of the object (Δt)

(iii) Nature of material of the object.

The quantity of heat required to raise the temperature of a unit mass of a substance by 1°C is called the specific heat of that substance. Its value reamins constant for a given material. The specific heat of water is greater than that of any other substance and its value is 1 cal g^{-1} $°C^{-1}$. Because of high specific heat capacity, water is used as coolant in many applications.

The formula to calculate the heat given to (or taken from) an object is given by

$$\boxed{H = m \times s \times \Delta t}$$

where, m = mass of the object

s = specific heat, specific heat can be defined as the heat given to (or taken from) an object of mass 1 kg to change its temperature by 1°C.

The common unit of heat is calorie (Cal) or kilocalorie (kCal).

However, the SI unit of heat is joule (J) because heat is a form of energy.

Δt = change in temperature

= Final temperature – Initial temperature

= $T_2 - T_1$

CALORIFIC VALUE OF FUELS:

Calorific value is defined as the total amount of heat energy produced by the complete combustion of a unit mass of fuel.

Calorific value, $C = \frac{Q}{M}$

Units of calorific value are J kg^{-1} or cal g^{-1}

Generally, gaseous fuels have high calorific value compared to that of solid and liquid fuels.

CHANGE OF STATE :

When water is heated after some time it will begin to boil. It will then turn into vapour. If solid substance like ice is heated it will reach a certain temperature and is converted into water.

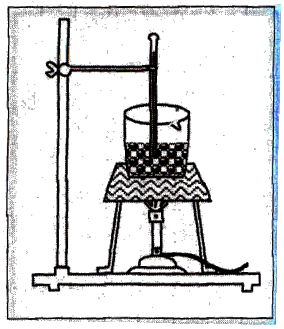
When water is cooled to a certain temperature it is converted to ice.This change of a solid into a liquid or liquid into a solid and a liquid into a gas or a gas into a liquid is called change of state of a substance.

A substance can undergo a change of state, only when heat is either given to it or taken away from it.

$$\text{Solid} \underset{\text{Heat released}}{\overset{\text{Heat absorbed}}{\rightleftharpoons}} \text{Liquid} \underset{\text{Heat released}}{\overset{\text{Heat absorbed}}{\rightleftharpoons}} \text{Gas}$$

Melting and Boiling point of a substance :

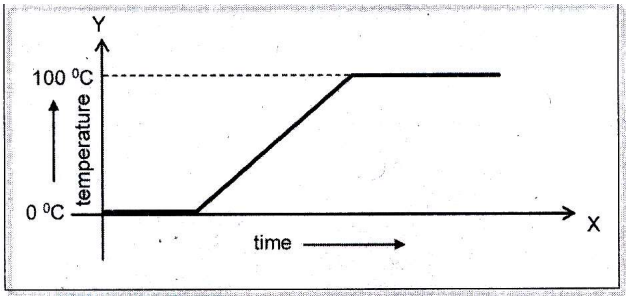
Take some crushed ice in a beaker. Place a thermometer in the ice and hold it upright as shown in Fig. Place the beaker on a stand. Heat the beaker by using a burner.



What do you observe Even though heat is being supplied temperature rises till 0°C and when it starts melting there is no change in the temperature shown by the thermometer until all the ice is melted. It remains at 0 °C.

On further heating, the temperature of water increases till 100 °C. At this temperature, water starts boiling. The temperature remains constant at 100 °C until all the water is evaporated.

If we plot a graph by taking heat supplied along X - axis and temperature along Y - axis, a curve as shown in the figure below is obtained.



What happened to the heat supplied? The heat supplied while the ice is changing into water was used up for changing the state. The constant temperature at which a solid substance changes into a liquid is called the **'melting point'** of the substance.
Similarly, the constant temperature at which a liquid substance starts to boil is called the **'boiling point'** of the substance.

'Freezing point' is the temperature at which a liquid substance changes into a solid when heat is taken away from it. The melting and freezing points of any substance are the same.

The process of changing a substance from gaseous state to liquid state at constant temperature by releasing heat energy is called condensation.That constant temperature at which the substance condenses is known as **condensation** point.

But some solid substances directly convert into gaseous state without converting into liquid state.The process of converting a solid directly into a gaseous state is called sublimation. That solid substance is called sublimate and the gaseous state of the substance is called **sublime**.

The process of changing a liquid substance into gaseous state at any temperature below its boiling point is known as **evaporation**. Evaporation is a slow process whereas boiling is a rapid process.

MODES OF TRANSFER OF HEAT :

The materials which allow heat to pass through them easily are called conductor of heat. For example aluminium, iron, copper. The materials which do not allow heat to pass through them are poor conductors of heat called insulators. For example plastic wood.

There are three modes of heat transfer-

1. **Conduction:** Conduction is the flow of heat through a substance without the movement of the particles of the substance.

Let us take an example of heating a solid rod by the process of conduction. The molecules in the solid rod are oscillating about their fixed position. As the molecule at one end get heated, they gain kinetic energy and start oscillating vigorously. They collide with the neighbouring molecules and transfer the extra energy to them. These gain kinetic energy and transfer it to their neighbouring molecules. In this way, heat is transmitted from one molecule to the next, down the whole rod, without the molecules actually moving from their positions. This process by which heat travels in solids is called conduction.

Conduction is a process of transfer of heat from the hotter end to the colder end from particle to particle of the medium. Conduction is the process of transmission of heat in solids, in which the molecules of the solid do not move from their position (only oscillate back and forth about their fixed positions) but merely transfer the heat energy in the form of kinetic energy from one molecule to the next.
Thus, medium is required for the transfer of heat by conduction, therefore, conduction is not possible in vacuum. In solids, heat is transferred mainly by the process of conduction.

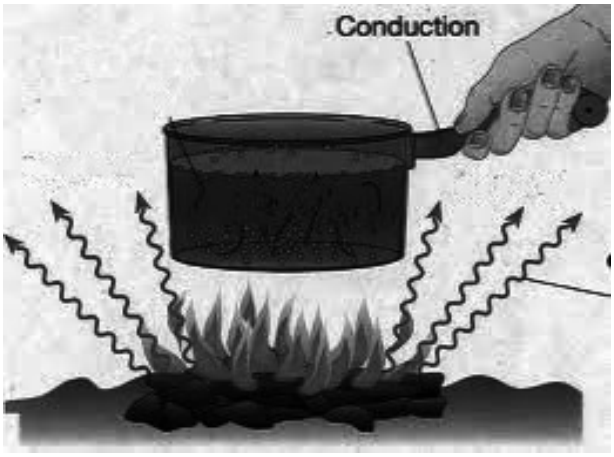
- **Types of conductors :**

(i) Good conductors : The substances through which heat energy can easily flow by conduction are called good conductors.

Eg.: Metals in general are good conductors. Amongst the metals, silver is best conductor, next in order are copper, aluminium, gold, etc.

Amongst non-metals graphite is a good conductor.
Metals are good conductor of heat. The high conductivity of metals can be attributed to the presence of a large number of free electrons. These electrons drift away from the source of heat when the metal is heated and in doing so carry the heat energy rapidly through the metal.

(ii) Bad conductors : The substances which do not allow the heat energy to flow through them easily are called poor conductors or bad conductors.



Eg. : Amongst the solid, glass, wood, clay, asbestos, rubber, plastics, wax, etc., are poor conductors.

All liquids except mercury are poor conductors. All gases without any exception are poor conductors.

- **NOTE :** Non-metals and organic substances are bad conductors. The low conductivity can be attributed to the lack of a large number of free electrons. It is because most of the heat energy can be transferred only through free electrons and not by the actual vibrational movement of its atoms.

- **Practical Applications of Good Conductors :**

(i) Copper tubing is used in the automobile radiators, as it readily takes up heat from the hot water coming from the side of engine.
(ii) Cooking vessels are made out of metals, so that they can readily absorb heat energy and transfer it to the food.
(iii) Mercury is used as a thermometric liquid, as it is a good conductor of heat.
(iv) Cooling coils of an air conditioner and the refrigerator are made of copper as they readily conduct heat.
(v) Tip of the soldering rod is made of copper, as it readily conducts away heat to the solder.

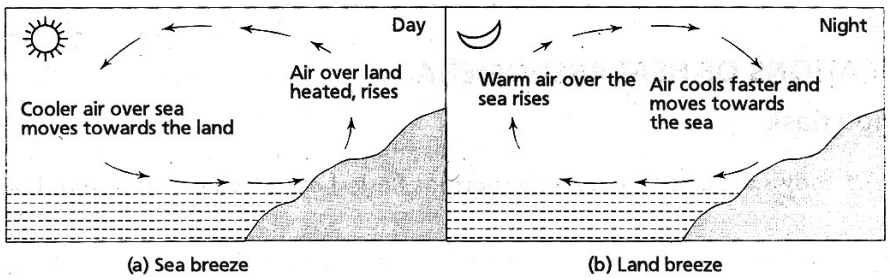
- **Practical applications of bad conductors :** We wear woolen clothes in the winter, because the woolen clothes contains a large amount of the trapped air. Since air is a bad conductor of heat, it does not allow the body heat to flow outward. As our body stops losing heat, we feel warm.

(b) Convection :

Convection is a process of transfer of heat by the actual movement of the medium particles. Liquids and gases are the bad conductors of heat. They are heated mainly by the process of convection. In a solid, the atoms cannot move, leaving their positions. So solids are not heated by convection. A medium is required for the transfer of heat by convection. Heat cannot be transferred by convection in vacuum. By the process of convection, the transfer of heat is always vertically upwards. The reason is that the medium particles near the source of heat absorb heat from the source and they start moving faster. As a result, the air at this place becomes less dense so it rises up in the medium which is called a convection current. The current continues till the entire liquid acquires the same temperature.

- **Consequence of convection :**
- **Land and sea breeze :** In the coastal regions, during summer it is noticed that a breeze generally blows from land towards the sea during the night (or early morning) which is called the land breeze.

Land is a better absorber of heat than water. During the day, the land gets hotter, the air above it rises and cooler air from over the sea flows in to take its place. This gives rise to a sea breeze that cools the land.



During night, the land radiates the heat it had absorbed during the day and cools down faster than the sea. Above the sea, the air is warmer. It rises and cooler air from the land moves towards the sea to take its place. This gives rise to a land breeze. Thus, we have a sea breeze during day time and a land breeze at night.

(c) Radiation :

Radiation is the process of heat transfer in which heat directly passes from one body to the other body without affecting the medium.

Thus, no medium is required for the heat transfer by the process of radiation. In vacuum, heat transfer takes place only by the process of radiation.

The heat energy transferred by the process of radiation is called the radiant heat or the thermal radiation.

(i) Nature of Radiant Heat : Heat energy is transferred by radiation in the form of electromagnetic waves. These waves can travel even in vacuum. They travel in all directions in straight line with a speed, equal to the speed of **light ($= 3 \times 10^8$ m s^{-1})**. They do not heat the medium through which they pass. They are reflected by a polished and white surface. When radiant heat falls on an object, it is partially absorbed and partially reflected. Dull, black or coloured surfaces are good absorber and good radiators of heat.

(ii) Properties of heat radiations :

(A) Heat radiations travel with the speed of light.

(B) Heat radiations can travel through vacuum.

(C) Heat radiations travel in straight lines.

(D) Heat radiations can travel in all directions.

(iii) Applications of heat radiations :

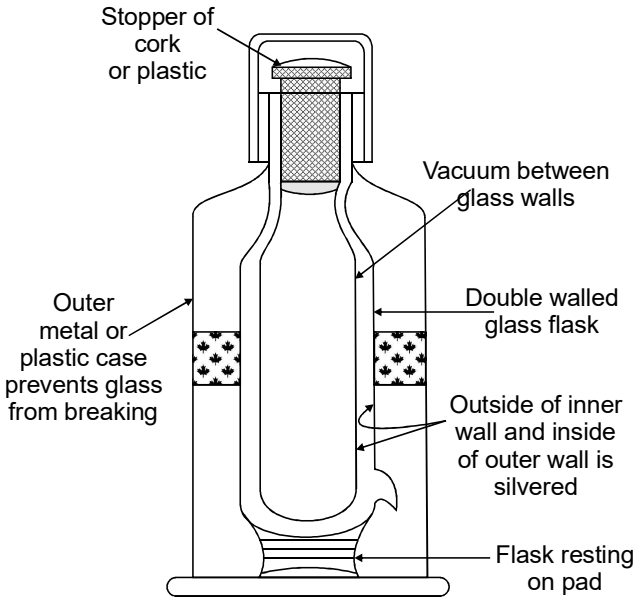
(A) Roofs of factories are painted white or with aluminium paint, because shining roofs are bad radiators of heat, but good reflector of heat.

(B) Metal teapots are kept shining as shining teapots are bad radiators of heat and hence tea remains hot for a long time.

(C) The cooking utensils are kept black from below and shining from the sides, because black surface absorb heat radiation rapidly, but the shining surfaces do not easily radiate heat. Thus, heat is trapped inside the cooking utensil and hence, cooking time is reduced.

THERMOS FLASK :

Hot tea is poured into the flask which is closed with the stopper at the top. The stopper is usually made of plastic which is a poor conductor of heat and prevents loss of heat from the top due to conduction. Since glass is also a poor conductor of heat, the glass double walls of the flask too prevent loss of heat. The insulation between the flask and the outer cover further prevents heat loss by conduction.



A thermos flask

The flask is closed at the top and warm air cannot escape from the top, so there is no loss of heat by convection. Between the two glass walls of the flask, there is vacuum (no air), so no heat can be lost through the walls of the flask due to conduction or convection.

The outer surface of the inner wall and inner surface of the outer wall (of the double glass walls) are silvered and are shiny. Thus, heat from inside cannot escape and heat from outside cannot enter by radiation as the silvered inner and outer surfaces reflect back this heat. Thus, a thermos flask prevents heat loss from inside the flask by conduction, convection and radiation.

IMPORTANT POINTS :

- In solids, heat is generally transferred by the method of conduction.
- In liquids and gases, heat is generally transferred by the method of convection.
- Heat from the sun reaches the earth by the method of radiation through space.
- Sea breeze blows during the day from the sea to the land and land breeze blows during the night from the land to the sea near coastal areas. These are examples of convection.
- In summer, we prefer light-coloured clothes and in winter, we usually wear dark-coloured clothes.
- Black objects are the best absorbers of radiant heat. Black objects are also the best radiators of heat.
- Shiny, smooth surfaces are better reflectors whereas dull, rough surfaces are better absorbers.

EXTENDED LEARNING - ACTIVITES AND PROJECTS

1. To prove that heat travels in metals via conduction :

- Take an iron rod.
- Fix four iron nails on it with wax.
- Place the rod as shown in figure.
- Heat the free end of the rod with a candle.
- What do you observe?

You will observe that the iron nail closest to the heated end of the rod falls as the wax melts. After some time, the second nearest nail falls and so on. From this activity, you can conclude that heat travels from one end to another through conduction.

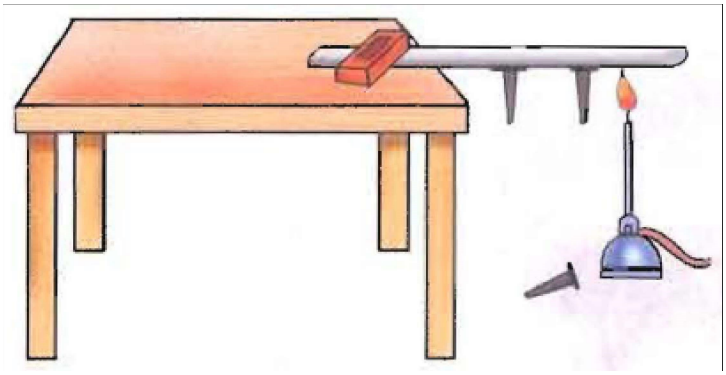
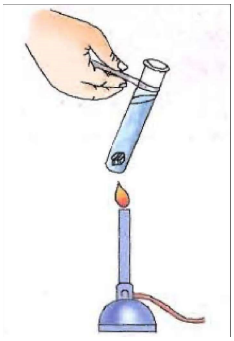


Figure : Heat flow through a metal rod

2. To show that water is a bad conductor of heat :

- Take a test tube and half fill it with cold water.
- Wrap a piece of ice in a copper wire gauze and drop it in the test tube.
- You will observe that it sinks to the bottom.
- Now hold the top end of the test tube with a test tube holder and heat it over a flame. You will notice that the water soon begins to boil but the ice is still not fully melted . This is because heat has not been transferred through the molecules of water. Thus, water is a poor conductor of heat.

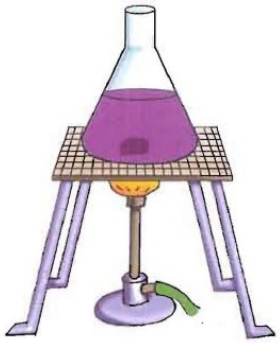


Water is a bad conductor of heat

3. To show that water transfers heat via convection :

- Take a conical flask and keep it on an iron stand.
- Fill it half with cold water.
- To it, add a large crystal of potassium permanganate.
- Heat it over a burner as shown is figure.
- What do you observe?

  You will observe that when the crystal is dropped in water, some of it dissolves and gives pink colour to water. As the water near the crystal is heated, it becomes lighter and rises. The rising water is hot and its molecules vibrate fast. In this process, they strike the molecules of cold water which come in their way and transfer some of their energy to them . As a result, their vibrations are reduced and the rising water becomes cold. In the meantime, more hot water rises pushing the cold water towards the sides of the flask. From the sides cold water comes down. This shows that water transfers heat by the movement of molecules from hotter to colder regions through convection.



Heat transfer through convection in water

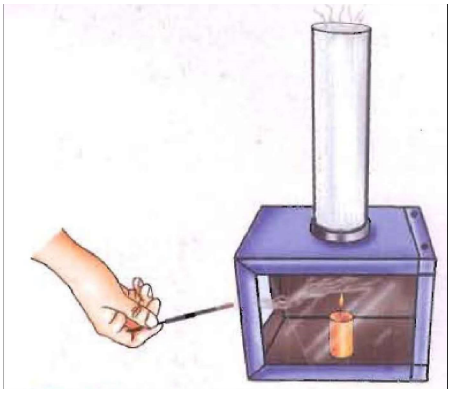
4. To show that air transfers heat via convection :

- Take a rectangular box with a glass front.
- Make a small window on one of its sides and a hole on its top .
- Fix a paper pipe into the hole at the top to form a chimney.
- Place a lighted candle in the box below the chimney.
- Keep your hand above the chimney.
- What do you observe?

  You will observe that hot air is coming out of the chimney.
- Now hold a lighted incense stick near the window.
- What do you observe now?

You will notice that smoke of the incense stick enters the box through the window. It then gets heated by the candle and comes out of the chimney. This happens because air inside the box gets heated and becomes lighter. This lighter air starts rising. To replace this air, smoke from the incense stick issucked into the box. You will see that smoke moves towards the candle flame, gets heated and rises. Finally, it leaves the box through the chimney.

This shows that convection current is set up in the box.



Heat transfer through convection in air

5. To prove that black bodies absorb and radiate heat better than white bodies :

- Take two identical cold drink cans filled with equal amount of water.
- Paint one can black and the other white.
- Place a thermometer in each can with the bulb of the thermometer properly dipped in water.
- Now place both the cans at an equal distance from the room heater.
- Switch the heater on and let it remain on for 15 minutes.
- Observe the readings in the thermometers.

You will observe that the temperature reading in the thermometer placed in the black can is higher than the thermometer placed . in the white can . This is so because black surface is a better absorber of heat radiation than white surface.

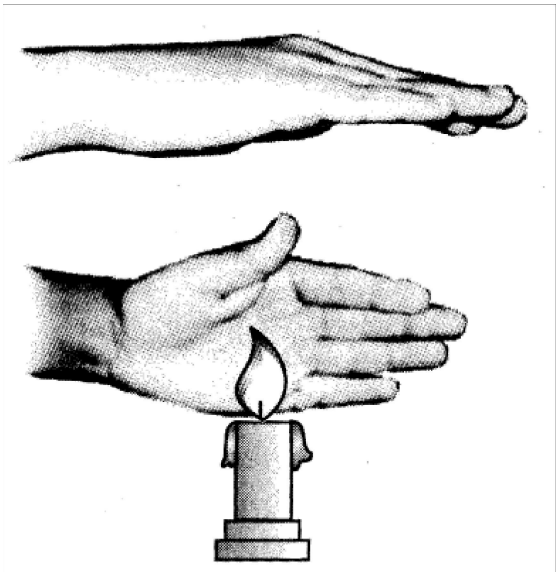
After switching off the heater, both the cans start emitting heat radiation to the surroundings.

- Leave them undisturbed for 10 minutes.
- Now check the readings in the thermometers . You will observe that the reading in the thermometer placed in the black can falls more rapidly than the thermometer placed in the white can. This is so because black surface is a better radiator of heat radiation than white surface.

Black bodies absorb and radiate more heat than white bodies.

Absorption of radiant heat by black and white cans

6. Light a candle. Keep one hand above the flame and one hand on the side of the flame (Fig.). Do your hands feel equally hot? If not which hand feels hotter? And why?



Transfer of heat by convection in air :

No. The hand above the flame feels hotter. This is because towards the top, the air gets heated by convection.

7. **Go to a doctor or your nearest health centre. Observe the doctor taking temperature of patients. Enquire:**

(a) **why she dips the thermometer in a liquid before use.**

(b) **why the thermometer is kept under the tongue.**

(c) **whether the body temperature can be measured by keeping the thermometer at some place other than the mouth.**

(d) **whether the temperature of different parts of the body is the same or different.**

You can add more questions which come to your mind.

(a) For disinfecting it.

(b) Thermometer is kept under the tongue because temperature under the tongue is near same as body temperature.

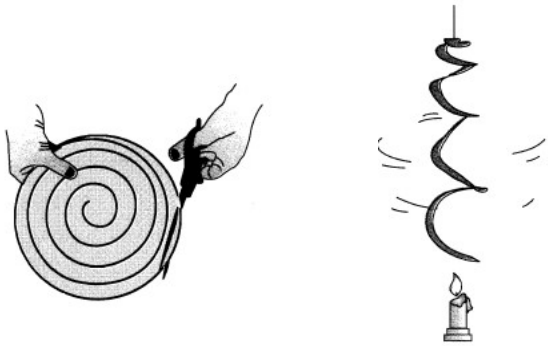
(c) Yes. Under the armpit.

(d) Differs slightly but average temperature is same.

8. **Wrap a thin paper strip tightly around an iron rod. Try to burn the paper with candle while rotating the iron rod continuously. Does it burn? Explain your observation.**

No, it does not burn. The iron being a good conductor of heat absorbs the heat supplied thus preventing the paper to attain ignition temperature.

9. Take a sheet of paper. Draw a spiral on it as shown in the Fig. Cut out the paper along the line. Suspend the paper as shown in Fig. above a lighted candle. Observe what happens. Think of an explanation.



Spiral ring of papers moves continuously. This may be due to the upward movement of hot air.

10. Take two similar transparent glass bottles having wide mouths. Put a few crystals of potassium permanganate or pour a few drops of ink in one bottle. Fill this bottle with hot water. Fill the other bottle with cold water. Cover the cold water bottle with a thick piece of paper such as a postcard. Press the postcard firmly with one hand and hold the bottle with the other hand. Invert the bottle and place it on top of the hot water bottle. Hold both the bottles firmly. Ask some other person to pull the postcard. Observe what happens. Explain.

In this activity hot water molecules move up to cold water. The process continues till the whole water gets uniformly coloured. Heat flows from a hot body to a cold body. Transfer of heat in liquid and gases is by the method of convection. Both liquids and gases are fluids.

LET US RECAPITULATE

1. We use so many hot and cold objects in our daily life.
2. By changing a certain temperature, we can change the state of the object from cold to hot and hot to cold.
3. Thermometer is a device to measure temperature.
4. Clinical thermometer: The thermometer that measures the temperature of our body is called aclinical thermometer. To avoid the toxicity of mercury, these days digital thermometers are available.
5. A clinical thermometer reads temperatures from 35°C to 42°C.
6. The normal temperature of a human body is 37°C.
7. The range of laboratory thermometer is generally from -l0ºC to 110°.
8. The heat flows from a body at a higher temperature to a body at a lower temperature. There are three ways in which heat can flow from one object to another. These are conduction, convection and radiation.
9. In solids, generally, the heat is transferred by conduction. In liquids and gases, the heat is transferred by convection. No medium is required for the transfer of heat by radiation.
10. From the sun, heat comes to us by radiation.
11. Dark-coloured objects absorb heat better than the light-coloured objects. That is the reason why we feel more comfortable in light-coloured clothes in summers.
12. Woollen clothes keep us warm during winter. It is so because wool is a poor conductor of heat and it gets air trapped in between the fibres to prevent the flow of heat from our body.
13. The materials which allow heat to pass through them easily are conductors of heat, for example: iron, copper etc.
14. The materials which do not allow heat to pass through them easily are called insulators, for example: plastic, wood etc.
15. Normal temperature of dog is 28°C, goat is 37 – 40°C and that of birds varies from 40°C to 45°C.
16. Birds use convection currents of air to rise high and glide effortlessly without flapping their wings.
17. The monsoon is also a convection current set up due to difference in temperature between the sea and the land.
18. Eakimos make igloos out of snow because snow contains a large amount of trapped air, which acts as an insulator and keeps the igloos warm.

KEYWORDS

1. **Celsius scale:** When the distance between the freezing point and the boiling point of water is equally divided into one hundred divisions, each division is termed as one degree and is written as 1°C.
2. **Conduction:** The process of transfer of heat from the hotter end to the colder end of an object due to contact is known as conduction. In solids, generally, the heat is transferred by the process of conduction.
3. **Conductor:** The materials which allow heat to pass through them easily are conductors of heat. Examples are aluminium, iron, copper etc.
4. **Convection:** It is the process of transfer of heat in water medium, from higher to its lower level.
5. **Insulators:** The materials which do not allow heat to pass through them easily are poor conductors of heat such as plastic and wood. Poor conductors are known as insulators.
6. **Land breeze:** At night, the above phenomenon becomes exactly reverse to sea breeze. The water cools down more slowly than the land. As a result, the cool air Ploves from land to sea. This phenomenon is called land breeze.
7. **Radiation:** Radiation is a process of transfer of heat in which no medium is required, for example: heat of sun that comes to us.
8. **Sea breeze :** In the costal areas, during the day time, the land air becomes hotter and resis up. The cooler air from the sea rushes towards the land. The hot air moves from land to sea to complete the cycle. Such phenomenon is called sea breeze.
9. Temperature : It is a reliable measure of the hotness of an object.
10. Thermometer: It is a device used to measure temperature.
11. Pure water and air are the poor conductors of heat.

CONCEPT APPLICATION LEVEL - I [NCERT Questions]

Q. 1 State similarities and differences between the laboratory thermometer and the clinical thermometer.

Ans. Similarities:

(i) Both consist of a long, narrow and uniform glass tube.

(ii) Both have a bulb at one end.

(iii) Both contain mercury in the bulb.

(iv) Both contain celsius scale on the glass tube.

Differences:

(i) A clinical thermometer shows temperature range from 35°C to 42°C, while a laboratory thermometer shows ranges between -l0°C to 110°C.

(ii) Clinical thermometer has a kink near the bulb while there is no kink in laboratory thermometer.

Q. 2 Give two exampies each of conductors and insulators of heat.

Ans. (i) Conductors of heat: Copper, iron.

(ii) Insulators: Plastic, wood (dry).

Q.3 Fill in the blanks:

(a) The hotness of an object is determined by its ..... .

(b) Temperature of boiling water cannot be measured by a ..... .thermometer.

(c) Temperature is measured in degree ..... .

(d) No medium is required for transfer of heat by the process of ..... .

(e) A cold steel spoon is dipped in a cup of hot milk. It transfers heat to its other end by the process of ..... .

(f) Clothes of .... colours absorb heat better than clothes of light colours.

Ans. (a) temperature (b) clinical (c) celsius (d) radiation
(e) conduction (f) dark

Q.4 Match the following:

(i) Land breeze blows during	(a) summer
(ii) Sea breeze blows during	(b) winter
(iii) Dark-coloured clothes are preferred during	(c) day
(iv) Light-coloured clothes are preferred during	(d) night

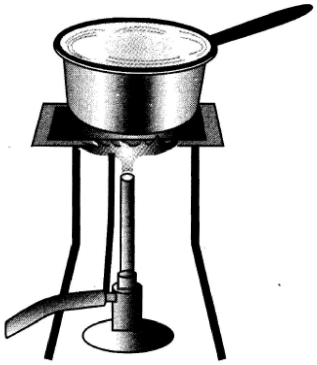
Ans.

(i) Land breeze blows during	(d) night
(ii) Sea breeze blows during	(c) day
(iii) Dark-coloured clothes are preferred during	(b) winter
(iv) Light-coloured clothes are preferred during	(a) summer

Q.5 Discuss why wearing more layers of clothing during winter keeps us warmer than wearing just one thick piece of clothing.

Ans. Wearing more layers of clothing during winter keeps us warmer than wearing just on~hick piece clothing because the air trapped between the two layers of clothes. This air prevents the flow of the heat from our body to the cold surroundings.

Q.6 Look at Fig. Mark where the heat is being transferred by conduction, by convection and by radiation.



Ans. In this figure, the heat is transferred at three points in different ways:
(i) by radiation: from flame to the bottom of pan.
(ii) by conduction: from lower surface to upper surface of the pan.
(iii) by convection: from the base to the upper region of pan water.

Q.7 In places ofhot climate it is advised that the outer walls ofhouses be painted white. Explain.
Ans. White colour reflects most of the heat that falls on it. When the outer walls of the houses in the places of hot climate are painted white, they reflect the heat falling on them and thus help in keeping the houses cool.

Q.8 One litre ofwater at 30°C is mixed with one litre ofwater at 50°C. The temperature of the mixture will be
(a) 80º (b) more than 50°C but less than 80ºC
(c) 20°C (d) between 30°C and 50°C
Ans. (d) between 30ºC and 50ºC.

Q.9 An iron ball at 40°C is dropped in a mug containing water at 40ºC. The heat will
(A) flow from iron ball to water.
(B) not flow from iron ball to water or from water to iron ball.
(C) flow from water to iron ball.
(D) increase the temperature of both.
Ans. (B) not flow from iron ball to water or from water to iron ball.

Q.10 A wooden spoon is dipped in a cup of ice cream. Its other end
(A) becomes cold by the process of conduction.
(B) becomes cold by the process of convection.
(C) becomes cold by the prcess of radiation.
(D) Does not become cold.
Ans. (D)

Q.11 Stainless steel pans are usually provided with copper bottoms. The reason for this could be that
(A) copper bottom makes the pan more durable.
(B) such pans appear colourful.
(C) copper is.a better conductor of heat than the stainless steel.
(D) copper is easier to clean than the stainless steel.
Ans. (C)

CONCEPT APPLICATION LEVEL - II

Hot and cold :

Q. 1 What is heat?

Ans. Heat is a form of energy. It enables us to feel hotness or coldness.

Q.2 What is temperature?

Ans. Temperature is the measurement of hotness of an object.

Q. 3 By which device temperature of an object is measured?

Ans. Thermometer.

Measuring Temperature :

Q. 1 Name the type of thermometer that is used to measure the body temperature.

Ans. Clinical thermometer.

Q. 2 What is the unit of temperature?

Ans. SI unit of temperature is Kelvin (K). Other units are celsius (0°C) and fahrenheit (0°F).

Q. 3 What is the range of clinical thermometer ?

Ans. 35°C to 42 ºC.

Q. 4 Give the names of any three kinds of thermometers.

Ans. (i) Clinical thermometer (ii) Laboratory thermometer
(iii) Maximum-mini.mum thermometer.

Q. 5 Explain the structure of a clinical thermometer.

Ans. A clinical thermometer consists of a long, narrow, uniform glass tube. It has a bulb at one end. This bulb contains mercury. Outside the bulb, a small shining thread of mercury can be seen. On the glass tube we can see a temperature scale, usually a celsius scale.

Q.6 Which metal is used in the bulb of clinical thermometer?

Ans. Mercury.

Q.7 What is the use of a kink present near the bulb of a clinical thermometer?

Ans. It prevents mercury level from falling on its own.

Q.8 What is the limitation of clinical thermometer?

Ans. A clinical thermometer reads temperature from 35°C to 42°C. Hence, it cannot be used to measure the temperature less than 35°C and above 42°C. It can break near a flame or sun.

Q.9 What precautions should we take while reading a clinical thermometer ?

Ans. Precautions to be observed while reading a clinical thermometer.

- Thermometer should be washed. before and after use, preferably with an antiseptic solution.
- Ensure that before starting the mercury level is below 35° .
- Read the thermometer keeping the level of mercury along the line of sight:
- Handle the thermometer with care. If it hit& against a hard object, it can break.
- Don't hold the thermometer by the bulb while reading it.
- Do not use this thermometer to measure temperature of other bodies.
- Do not keep this thermometer near a flame or sun, as it might break.

Q.10 Is the body temperature of every person 37°C? Why?

Ans. The temperature of every person may not be 37ºC. It could be slightly higher or slightly lower. Actually what we call normal temperature is the average body temperature of a healthy person.

Q. 11 What is the temperature of. healthy person?

Ans. 37°C.

Q. 12. The temperature of man on celsius scale is 37°C. What will it be on fahrenheit scale?

Ans. 98.6 ºF.

Q. 13 Why is the range of a clinical thermometer kept between 35°C and 42°C?

Ans. The clinical thermometer is designed to measure the temperature of human body only. The temperature of human body normally does not go below 35°C or above 42°C. That is the reason why this thermometer has the range between 35°C and 42°C.

Q.14 Why we use mercury as the thermometric liquid ?

Ans.
- Expands easily and uniformly on heating.
- Can be used over a wide range of temperatures.
- Easily visible, being opaque and shining.
- Does not stick to the sides of a glass tube.

Q.15 Why digital thermometer is more popular than mercury thermometer ?

Ans. Mercury is toxic in nature. If a thermometer breaks it is difficult to dispose of the mercury. So nowadays, mercury thermometers are being replaced by digital thermometers that do not use mercury.

Laboratory Thermometer :

Q.1 What is a laboratory thermometer ?

Ans. A thermometer used in laboratory for measuring temperature of various objects is known as laboratory thermomenter. The range of a laboratory thermometer is generally from –10ºC to 110ºC.

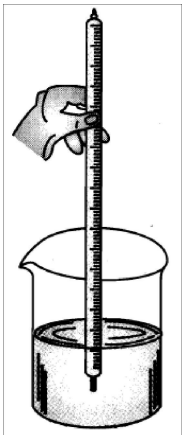
Q.2 What is the range of laboratory thermometer ?

Ans. –10ºC to 110ºC.

Q.3 Why it is not advisable to use laboratory thermometer to measure the temperature of human body ?

Ans. It is not advisable to use laboratory thermometer to measure the temperature of human body because it has no kink to prevent the mercury level from falling, it can also give less reading of body temperature. Hence, it is not convenient to use the laboratory thermometer for this purpose.

Q. 4. Illustrate, how the temperature of water can be measured with laboratory thermometer?



Ans. To measure the temperature of water with the help of laboratory thermometer take the sample of water in a beaker or a mug. Dip the thermometer in the water so that its bulb gets immersed completely in water but does not touch the bottom of the beaker or its sides. Hold the thermometer vertically. Observe the movement of mercury thread until it becomes steady. Note the reading.

Q. 5 Why does the mercury not fall or rise in a clinical thermometer when taken out of the mouth?

Ans. There is a kink near the bulb of a clinical thermometer. It prevents mercury level from falling on its own.

Q. 6 Can you use clinical thermometer to measure the temperature of a candle flame?

Ans. No, we cannot measure the temperature of a candle flame by clinical thermometer. It is because the temperature of candle flame is more than the temperature of the upper fixed point (42°C) of clinical thermometer. If we try to measure the temperature of candle flame by this thermometer, it might break.

Transfer of heat :

Q. 1 What is conduction ?

Ans. The process by which heat is transferred from the hotter end to the colder end of an object is known as conduction. In solids, generally, the heat is transferred by the process of conduction.

Q. 2 What is the method of transfer of heat in most of the solids?

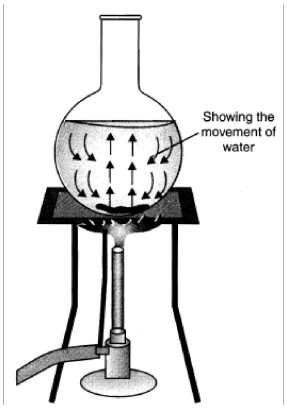
Ans. Conduction. .

Q. 3 What are conductors and insulators? Explain giving examples.

Ans. The materials which allow heat to pass through them easily are conductors of heat. Examples are all metallic objects. Materials which do not allow heat to pass through them easily are poor conductors of heat such as plastic and wood. They are also known as insulators.

Q. 4 How does the heat travel in water or in gases?

Ans. When water is heated, the water near the flame gets hot. Hot water rises up. The cold water from the sides moves down towards the source of heat. This water also gets hot and rises and water from sides moves down. This process continues till the whole water gets heated. This mode of heat transfer is known as convection.



Q. 5 Water and air are poor conductors of heat. Then how does the heat transfer take place in these substances?

Ans. By convection.

Q.6 Why is the handle of a metallic kettle covered with strips of cane?

Ans. Handle of a metallic kettle is covered with strips of cane because when kettle is heated the heat does not pass through strips ofcane because strips of cane are bad conductors of heat and only then we may hold the handle with bare hands.

Q. 7 How does the heat travel in air? Explain the sea breeze and land breeze in coastal areas in this reference.

Ans. The air near the heat source gets hot and rises. It leaves the place, which is filled by the cold air from the sides. In this way the air gets heated.

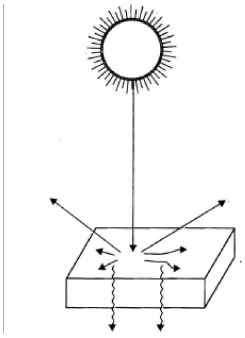
The people in coastal areas experience an interesting phenomenon. During the day, the land gets heated faster than water. The air over the land becomes hotter and rises up. The cooler air from the sea rushes in towards the land to take its place. The warm air from the land moves towards the sea to complete the cycle. The air from the sea is called the sea breeze. To receive the cooler sea breeze, the windows of the houses in coastal areas are made to face the sea. At night, it is exactly the reverse. The water cools down more slowly than land. So the cool air from the land moves towards the sea. This is called the land breeze.

Q. 8 Write a short essay on 'Radiation'.

Ans. The solar energy reaches to us by a process known as radiation.

The transfer ofheat by radiation does not require any medium. It can take place whether a medium is present or not. When we sit in front of a room heater, we get heat by this process. A hot utensil when kept away from the flame, cools down as it transfers heat to the surroundings by radiation. Our body too gives heat to the surroundings and receives heat from it by radiation. All hot bodies radiate heat. When this heat falls on some object, it divides ·into three different ways:

- a part of it is reflected.
- a part of it gets absorbed.
- a part of it may be transmitted.



Q.9 In which method of transfer of heat no medium is required?

Ans. Radiation.

Q.10 By which method we get heat from the sun ?
Ans. Radiation.

Q. 11 Name three methods of transfer of heat.
Ans. (i) Conduction (ii) Convection (iii) Radiation.

Q. 12. Is it possible to construct buildings that are not affected by outside cold or heat?
Ans. Yes, it is possible to construct buildings which are not affected much by heat and cold outside the building. This can be done by making outer walls of the building in such a manner that they trap a layer of air. This can be done by using hollow bricks.

Kinds of clothes we wear in summer and winter :

Q. 1 What kind of cloth we prefer in summer?
Ans. In summer we prefer light-coloured clothes.

Q. 2 Why are dark coloured clothes preferred in winters?
Ans. Because dark-coloured clothes absorb most of the heat falling on them, thus they keep us warm.

Q. 3 Why is it more comfortable to wear white or light coloured clothes in the summer and dark coloured clothes in the winter?
Ans. Dark surfaces absorb more heat and, therefore, we feel comfortable with dark coloured clothes in the winter. Light-coloured clothes reflect most of the heat that fall on them and, therefore, we feel'more comfortable wearing them in the summer.

Q. 4 How woollen clothes keep us warm in winter?
Ans. In the winter we use woollen clothes. Wool is a poor conductor of heat. Moreover, there is air trapped in between the wool fibres. This air prevents the flow of heat from our body to the cold surroundings. So, we feel warm.

CONCEPT APPLICATION LEVEL - III

Section–A

Q.1 Match the items given in Column I with those given in Column II:

Column I	Column II
(i) Conduction	(a) Wood, Plastic, Wool, Air, Water
(ii) Convection	(b) Day time
(iii) radiation	(c) Solids
(iv) Conductors	(d) Night
(v) Insulators	(e) Liquids
(vi) Land breeze	(f) Metals
(vii) Sea breeze	(g) A device to measure the degree of hotness
(viii) Dark colour surfaces	(h) Poor absorbers of heat
(ix) Light coloured surface	(i) Good absorbers of heat
(x) Thermometer	(j) Requires no medium

Section–B

Q.2 Fill in the blank space in following statements:

(i) Temperature is the measure of ..... of an boject.
(ii) The thermometer used to measure human body temperature is called ..... thermometer.
(iii) The normal temperature of human body is ..... ºC.
(iv) A ..... near the bulb of a clinical thermometer perevents mercury level from falling of its own.
(v) In ..... generally, te heat is transferred by the process of conduction.
(vi) The water and air are ..... conductors of heat.
(vii) In coastal areas, cold air flows in the day from sea to land. It is called ..... .
(viii) When we come out in the sun we feel ..... .
(ix) All hot bodies radiate ..... .
(x) Wool is a ..... conductor of heat.

Section–C

Q.3 **Choose the true and false statements from the following:**

(i) Our sense of touch about hotness or coldness is not always reliable.
(ii) Normal temperature of human body is 98. 6°C.
(iii) In all cases heat flows from a hotter object to a colder object.
(iv) Water at higher temperature feels more hot.
(v) Marking on clinical thermometer is from 0°C to 100°C .
(vi) Shining thread in thermometer is the column of mercury.
(vii) The materials which allow heat to pass through them easily are called conductors.
(viii) Water and air are good conductors of heat.
(ix) Woollen clothes keep us warm during winter.
(x) The maximum and minimum temperature of the day is measured by a laboratory thermometer.

Section–D

OBJECTIVE TYPE QUESTIONS

Q.1 Which one of the following is a reliable measure?
(A) Hotness (B) Coldness (C) Temperature (D) None of these

Q.2 Name the device which is used to measure the hotness or coldness of an object.
(A) Picometer (B) Barometer (C) Manometer (D) Thermometer

Q.3 What is the SI unit of temperature ?
(A) Kelvin (B) Celsius (C) Fahrenheit (D) All

Q.4 What is the range of a clinical thermometer ?
(A) 0ºC to 100ºC (B) 35ºC to 42°C (C) – 10ºC to 11ºC (D) None of these

Q.5 Which one is filled in the bulb of a thermometer?
(A) Mercury (B) Lead (C) Copper (D) Silver

Q.6 What is the normal temperature of a healthy person?
(A) 37°C (B) 37°F (C) 37 K (D) None of these

Q.7 Heat always flows
(A) from a colder object to a hotter object (B) from a hotter object to a colder object
(C) in both the directions (D) heat never flows from one object to other

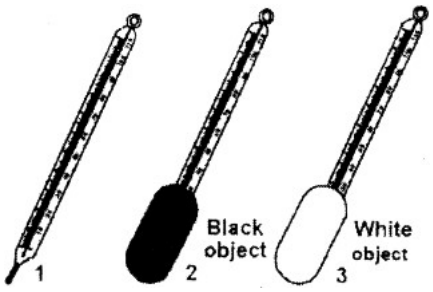
Q.8 Conduction is the method of transfer of heat in
(A) liquids (B) solids (C) gases (D) vacuum

Q.9 Heat from the sun reaches to us by
(A) radiation (B) conduction (C) convection (D) all of these

Q.10 Which kind of cloth will you prefer the most in summers?
(A) Thin cloths with black colour (B) Thick cloths with white colour
(C) Thick cloths with black colour (D) Thin cloths with white colour

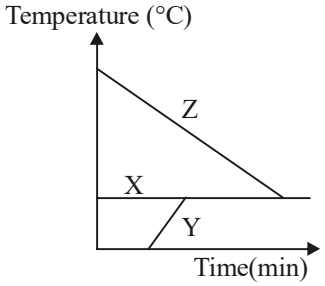
Q.11 Which one will you prefer on a cold night?
(A) Two thin blankets joined together (B) One thick blanket
(C) Give equal preference to both (D) Cannot say

Q.12 Rohan wants to test whether a white object or a black object would heat up faster in the Sun. The picture shows you his experiment which uses three thermometer 1, 2 and 3. These thermometers were left out in the Sun for 30 minutes.
Which of the following statements is true ?
(A) Thermometer 1 reads the same as thermometer 3
(B) Thermometer 2 shows a higher temperature than thermometer 3
(C) Thermometer 3 shows higher temperature than thermometer 1
(D) Thermometer 1 reads the same as thermometer 2

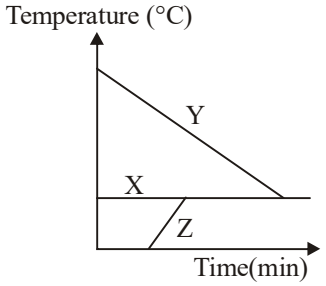


Q.13 Three identical containers X, Y and Z were filled with the same amount of tap water, boiling water and ice respectively and left in a room. Which one of the following graphs correctly shows the change in the temperature of the content in each container after some time ?

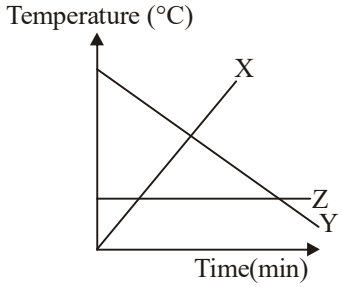
(A)



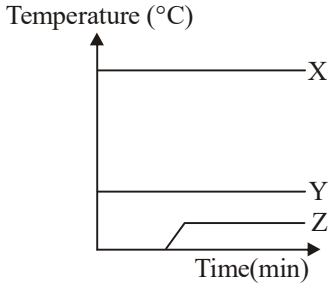
(B)



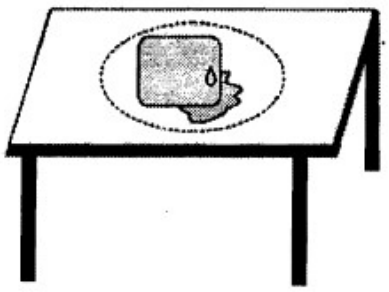
(C)



(D)

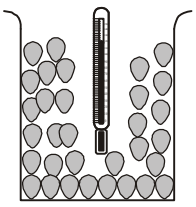


Q.14 An ice cube was left on the table as shown in the diagram. After a while, the ice cube started to melt. What inference can we make about the observation ?



a. The ice cube had gained heat.
b. The ice cube had lost heat
c. The temperature of the ice had increased
d. The temperature of the ice had decreased
(A) a only (B) a and c only (C) b and c only (D) b and d only

Q.15 The warm water is poured slowly into beaker of ice cubes as shown in figure. Which of the following options is correct, when the warm water was poured into the beaker ?

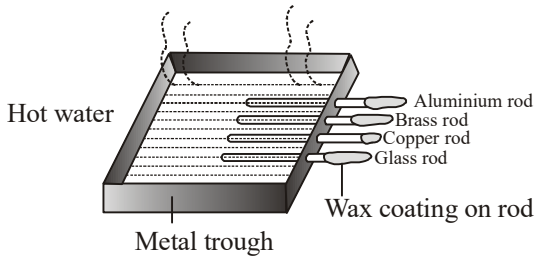


a. The ice starts to melt
b. The glass expands
c. The temperature of the ice increases
d. The temperature of the warm water decreases
(A) a and d only (B) b and d only (C) a, c and d only (D) All of these

Q.16 The temperature shown by a mercury-in-glass thermometer increases. Which of the following is constant ?

(A) Density of the mercury
(B) Internal energy of the mercury
(C) Mass of the mercury
(D) Volume of the mercury

Q.17 Four rods of equal length and thickness but of different materials are coated with wax in the same manner. They are fixed to a trough containing hot water. The given diagram illustrates what happens to the wax on each rod after five minutes.

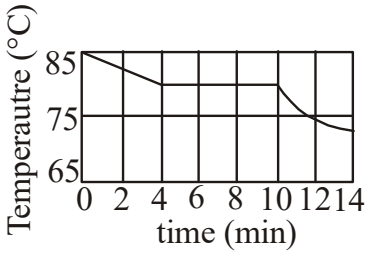


What can you conclude from the given diagram ?

(i) Aluminium rod can conduct heat better than the brass rod.
(ii) The aluminium rod conducts heat better than the copper rod
(iii) The glass rod conducts heat better than the copper rod
(iv) The wax on the copper rod melts faster than the wax on the brass rod.

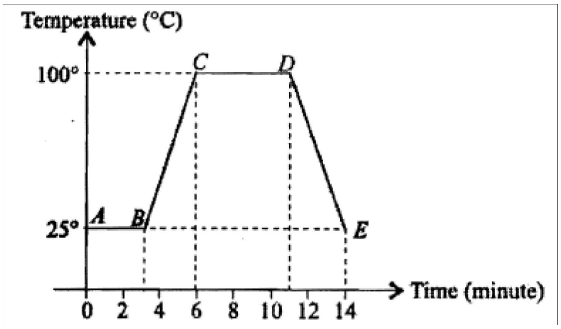
(A) (i) and (iv) only
(B) (ii) and (iii) only
(C) (i), (ii), and (iii) only
(D) (ii), (iii) and (iv) only

Q.18 The hot liquid is poured into a test tube. The figure shows how the temperature of the contents of the test tube changes with time what is the physical state of the contents of the tube at time 8 minute ?



(A) Mixture of liquid and vapour
(B) Mixture of liquid and solid
(C) Liquid
(D) Solid

Q.19 The temperature changes in a closed kettle of water was recorded for 14 minutes and represented in the graph below. Which of the following statement is true ?



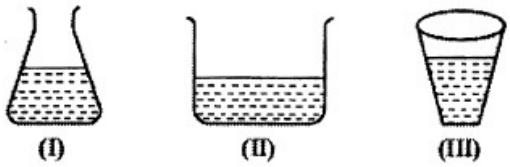
(A) The kettle of water was heated for 6 minutes
(B) There was less water in the kettle at point E than at point A
(C) The water took 6 minutes to reach its boiling point after it was heated
(D) The water in the kettle started boiling at C

Q.20 When you heat a system, its temperature _____
(A) Always increases
(B) Sometimes decreases
(C) May stay the same
(D) Always goes up or down, depending on the heat

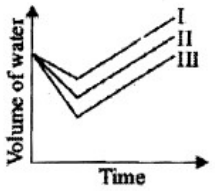
Q.21 A laboratory thermometer gave the reading of – 1°C and 99°C when inserted into melting ice and boiling water respectively, both at standard atmospheric pressure. What is the error when the same thermometer is used to measure the difference between two arbitrary temperature ?
(A) – 1°C (B) 1°C (C) 0°C (D) 2°C

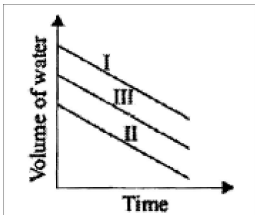
Q.22 Metal pots are often made shiny on surface outside especially on the top and side and that makes sense thermally because this _____.
(A) Conducts heat better (B) Radiates less energy out from the pot
(C) Lowers the loss due to conduction (D) Appreciably decreases convection losses

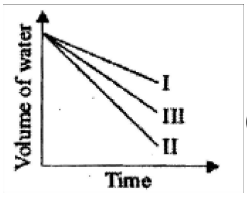
Q.23 50 mL of water at 25°C was poured into each of the three containers as shown in the given figure. The containers were then left in a closed room.

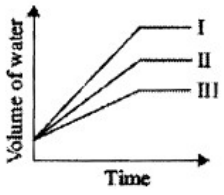


Which of the following graphs correctly shows the volume of water in each container after five hours ?

(A) 

(B) 

(C) 

(D) 

Q.24 The melting point of a substance is 125°C, and its boiling point is 305°C. At 105°C, the substance is in the _____.
(A) Solid state (B) Liquid state
(C) Gaseous state (D) Solid and liquid state

Q.25 A sphere, a cube and a thin circular plate, all of same material and same mass, are initially heated to same high temperature. Then the _____.
(A) Sphere will cool fastest and cube the slowest
(B) Plate will cool fastest and sphere the slowest
(C) Cube will cool fastest and sphere the slowest
(D) Sphere will cool fastest and plate the slowest

ANSWER KEY

CONCEPT APPLICATION LEVEL - III

Section–A

Q. 1 Match the items in Column I with Column II:

Column I	Column II
(i) Conduction	(c) Solids
(ii) Convection	(e) Liquids
(iii) radiation	(j) Requires no medium
(iv) Conductors	(f) Metals
(v) Insulators	(a) Wood, Plastic, Wool, Air, Water
(vi) Land breeze	(d) Night
(vii) Sea breeze	(b) Day time
(viii) Dark colour surfaces	(i) Good absorbers of heat
(ix) Light coloured surface	(h) Poor absorbers of heat
(x) Thermometer	(g) A device to measure the degree of hotness

Section–B

Q. 2 Fill in the blanks:

(i) hotness (ii) clinical (iii) 37 (iv) kink (v) solids (vi) poor
(vii) sea breeze (viii) warm (ix) heat (x) poor

Section–C

Q. 3 True/False:

(i) True (ii) False (iii) True (iv) True (v) False (vi) True
(vii) True (viii) False (ix) True (x) False

Section–D

Q.1	C	Q.2	D	Q.3	A	Q.4	B	Q.5	A	Q.6	A	Q.7	B
Q.8	B	Q.9	B	Q.10	D	Q.11	A	Q.12	B	Q.13	B	Q.14	B
Q.15	C	Q.16	C	Q.17	A	Q.18	B	Q.19	D	Q.20	C	Q.21	C
Q.22	B	Q.23	C	Q.24	A	Q.25	B						