HEAT

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INTRODUCTION

Heat : It is a form of energy which causes the sensation of hotness or coldness.

For example, if we dip our finger in hot water we have a sensation of hotness. Similarly, If we touch a block of ice the sensation is that of coldness. In the former case the heat energy has moved into the finger while in the later case it has moved out of the finger. Thus hotness or coldness basically indicates whether heat energy is flowing into our body or out of it.

Temperature : It is the effect of heat energy which determines the thermal state of a given substance. In other words it determines the degree of hotness or coldness of a substance. If a body is at a higher temperature than its surroundings, it means that heat energy will flow out of the body. Similarly, if a body is at a lower temperature than its surroundings, it means that heat energy will flow into the body.

Measurement of temperature

The instrument used for the measurement of temperature is called thermometer.

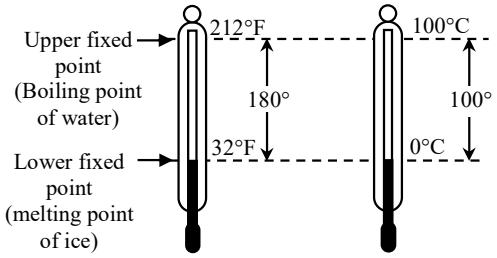
DIFFERENT SCALES OF TEMPERATURE

(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. On this scale **0°C** represent melting point of ice & **100°C** represent steam point. Each division on this scale is called one degree centigrade or one degree Celsius and is written as **°C.**

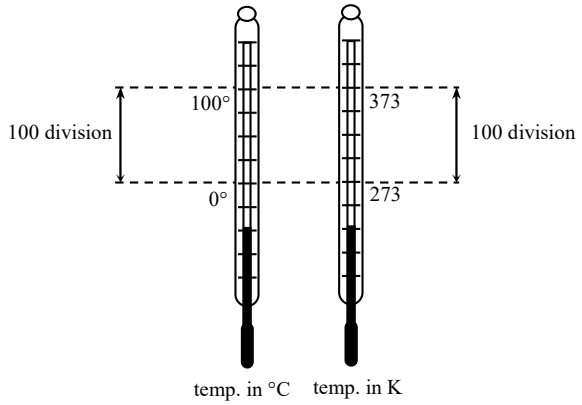
(B) Fahrenheit Scale :

The scale was introduced by Fahrenheit. On this scale **32°F** represents the melting point of ice and **212°F** the steam point . Zero is marked **32°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°F. This scale is widely used for meteorological and clinical purposes.



(C) Kelvin Scale

The scale of measurement of temperature, in which lowest temperature is **zero Kelvin (– 273°C)** is called **Kelvin scale**. Thus is also called S.I. scale of temperature.



Characteristics of Kelvin scale

(i) There cannot be any temperature below zero Kelvin

(ii) Rise in temperature in Kelvin = Rise in temperature in degree Celsius.

ROLE OF TEMPERATURE IN TRANSFER OF HEAT ENERGY

When two bodies at different temperature 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 temperature equalise. Thus, it is the temperature of body which determines the direction of flow of heat energy.

UNIT 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°C (14.5 °C to 15.5°C) is called one calories .

EFFECTS OF HEAT

Temperature rises with heat

When you heat something, or supply it with heat, its temperature rises. You would have notice this in the activity in which you measured the temperature of boiling water. The converse is also true. When you cool something, its temperature falls. Cooling something is the same as taking away heat from it.

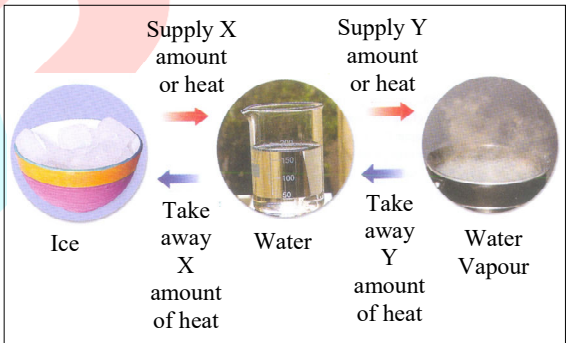
Heat causes expansion

All substances, whether solid, liquid or gaseous, expand when they are heated and contract when they are cooled. However, the extent to which they expand is different. **Expansion is the greatest in gases, less in liquids, and the least in solid**.

Ex. Fit a balloon to the mouth of a glass bottle. Place the bottle in a pan of water and heat it. The balloon will get inflated as the air inside the bottle becomes warm and expands. Take the bottle out of the pan and allow it to cool. The balloon will get deflated as the air inside the bottle contracts.

Heat causes change of state

When you heat a solid, it melts. And when you heat a liquid, it ultimately boils and changes into vapour. Conversely, when you cool a vapour, or take away heat from it, it changes into a liquid. And when you cool a liquid, or take away heat from it, it changes into a solid.



Heat causes change of state

TRANSFER OF HEAT

Heat can be transferred by three methods-

(a) conduction

(b) Convection

(c) Radiation

(a) Conduction ;

Heat is transferred by the process of conduction when bodies at different temperatures are in direct or indirect physical contact

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.

Ex. Metals in general are good conductors. Amongst the metals, silver is considered best conductors. Amongst non-metal graphite is a good conductor. Metals are good conductor of heat

(ii) Bad conductors

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

Ex. 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.

◈ **Practical Application of good conductors**

- Cooper tubing is used in the automobile radiators, as it readily takes up heat from the hot water coming from the side of engine
- Cooking vessels are made out of metals, so that they can readily absorb heat energy and transfer it to the food.
- Mercury is used as a thermometric liquid, as it is a good conductor of heat
- Cooling coils of an air conditioner and the refrigerator are made of copper as they readily conduct heat.

◈ **Practical Application 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 :

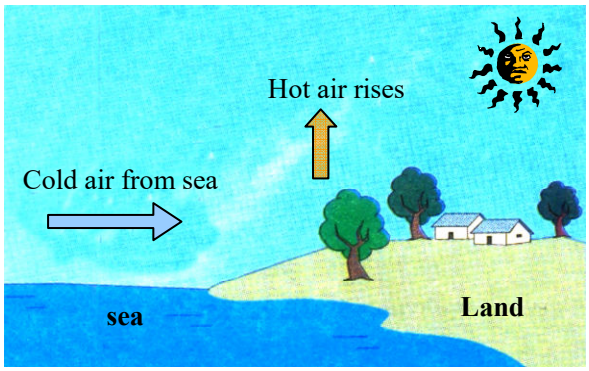
Convection is a process of transfer of heat by the actual movement of the medium particles. Liquids and gases are the bad conductor of heat. they are heated mainly by the process of convection. In a solid, the atoms cannot move, leaving their positions, So solids are not heated by convection. A medium is required for the transfer of heat by convection. Heat cannot be transferred by convection in vacuum.

◈ **Consequence of convection :**

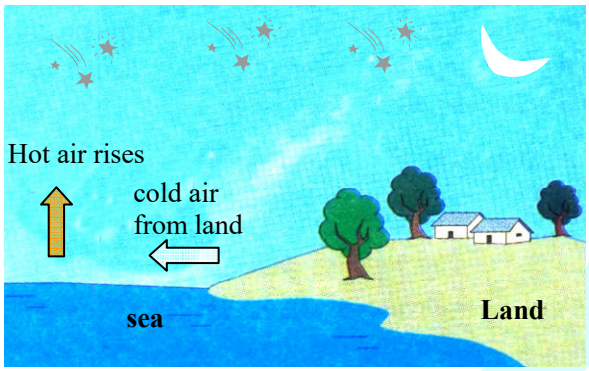
Land and sea breeze

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.



Land breeze



Sea breeze

During night, the land radiates the heat it had absorbed during the day 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.

- **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 direction in straight line with a speed equal to the speed of light (= 3×10^8 ms^{-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.
- **Properties of heat radiations**

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

  (B) Heat radiations can travel through vacuum

  (C) Heat radiations travels in straight lines

➢ POINTS TO REMEMBER

- Heat is a form of energy. We use this energy to generate electricity, among other things.
- The hotness or coldness of a body is relative.
- The temperature of a body is a measure of the degree of hotness of the body. We measure it by comparing it with a universal standard.
- The Celsius and Fahrenheit scales are commonly used to measure temperature. Ice melts at 0ºC or 32ºF. and water boils at 100ºC or 212ºF.
- Heat causes a rise in temperature. It also causes expansion and change in the state of matter.
- Heat flows or travels in three ways – conduction, convection and radiation.
- Conduction is the process by which heat flows through a substance without the movement of the substance itself.
- Convection is the process of transfer of heat in a liquid or gas by the movement of the liquid or gas.

- Radiation s the process by which heat travels without the help of a material medium. Radiant heat travels in straight lines, in all direction from a hot body.
- Every body emits (gives out) radiant heat. The emission of radiant heat from a body depends upon its temperature and colour.
- When radiant heat falls on a body, a part of it is absorbed and the rest is reflected. How much radiant heat a body absorbs and how much it reflects depend on its colour and the nature of its surface. Shiny white bodies are the best reflectors, while rough black bodies are the best absorbers of radiant heat. Black bodies absorb and emit radiant heat the best.