

3. EFFECTS OF HEAT

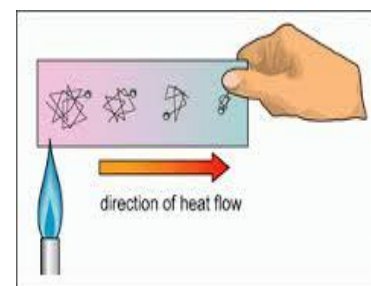
In the previous class you have learnt that heat is a form of energy. Heat can be obtained from various sources like the sun, fire, etc. When we read the weather forecast we observe that the temperature in the month of March is 36°C and in the month of January it is 21°C . Why is there a difference in temperature? Are heat and temperature different? We will discuss about this in this chapter.

3.1 Heat and temperature

Heat is a form of energy. When any substance is heated its temperature rises. Although heat and temperature are closely related yet they are different from each other. When we put our finger into a glass of hot water we feel hot. This is because heat from the hot water flows into our body. When an ice cube is placed on our palm, we feel cold. This is because the heat from our body moves into the ice cube.

Thus, heat can be defined as a form of energy that gives the sensation of hotness or coldness

Heat always flows from a hot body to a cold body till both the bodies have the same temperature or they have attained thermal equilibrium.



Temperature is a quantitative measure of heat. It tells us how hot or cold a body is.

Thus, temperature can be defined as the degree of hotness or coldness of a body.

Difference between heat and temperature

	Heat	Temperature
1	It is a form of energy that gives a sensation of hotness or coldness	It is the degree of hotness or coldness of an object.
2	Its SI unit is Joule (J).	Its SI unit is Kelvin (K)
3	Heat is measured using a calorimeter.	Temperature is measured using a thermometer.
4	It changes with the mass of the substance	It does not depend on the mass of the substance.

3.2 Effects of heat

When a body is heated 3 effects are observed

- Change in state.
- Change in temperature.
- Thermal expansion.

Change in temperature

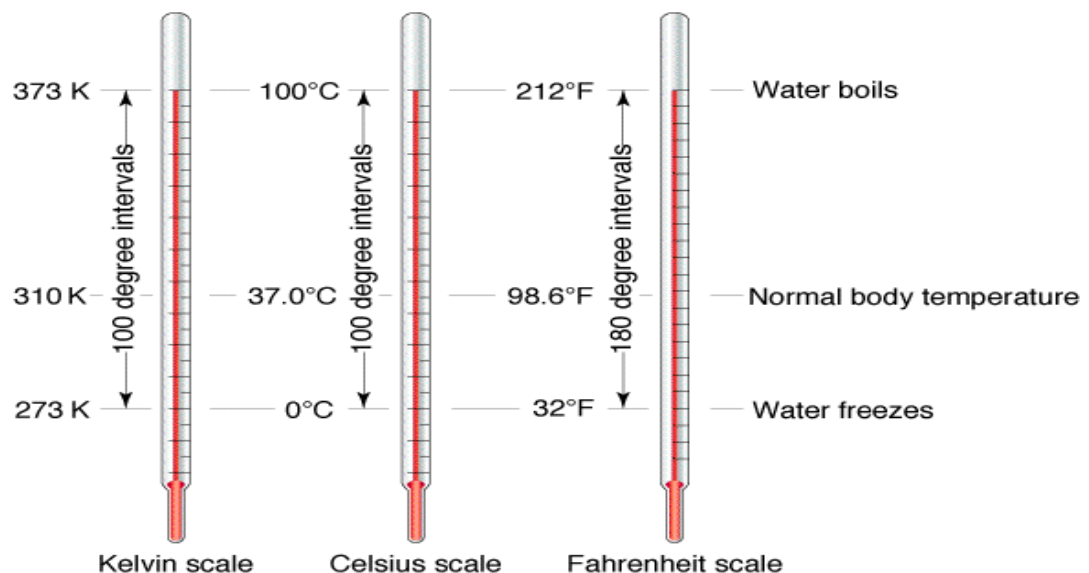
When a body is heated, its temperature increases. When a body is cooled, its temperature decreases. This change in temperature is measured using a thermometer.

The basic principle behind a thermometer is that it consists of a liquid known as thermometric fluid, which expands on heating. The thermometer contains mercury or alcohol as the thermometric fluid. The thermometer is calibrated using different temperature scales that help us to note the change in temperature.

Temperature scales

The three temperature scales that we use are

- The Fahrenheit scale.
- The Celsius scale.
- The Kelvin scale.



Fahrenheit scale was created by Gabriel Daniel Fahrenheit. On this scale water freezes at 32°F and boils at 212°F. The interval between the boiling point and freezing point of water is divided into 180 equal degrees.

Celsius scale was created by Anders Celsius. On the Celsius scale, the freezing point of water is 0°C, and the boiling point 100°C. The scale is divided into 100 equal degrees between those two points.

Kelvin scale is named after William Thompson Kelvin. It is based on a single point (**absolute zero**) which is given a value of 0 degrees. From there, the scale increases by degrees that are the same size as Celsius degrees. On the Kelvin scale, the freezing point of water is 273 K and the boiling point is 373 K.

Relationship between the temperature scales

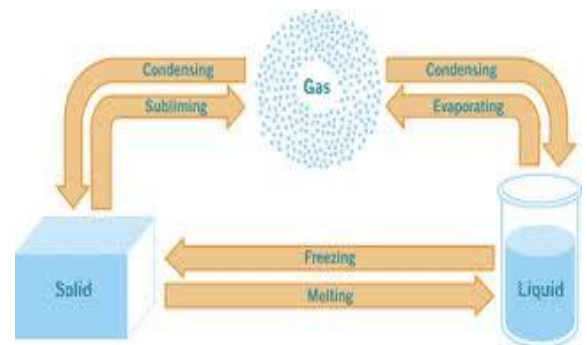
$$^{\circ}\text{F} = \frac{9}{5} ^{\circ}\text{C} + 32$$

$$^{\circ}\text{C} = \frac{5}{9} \times (^{\circ}\text{F} - 32)$$

$$\text{K} = ^{\circ}\text{C} + 273$$

Change in state

When a body is heated, the random motion of the molecules may not always increase. Heat may change the arrangement of the molecules inside the body, thereby changing the state of the body, with the temperature remaining constant.

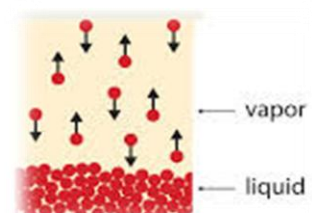


Melting or Fusion

It is the change of state from solid to liquid by the absorption of heat. For example, when ice is removed from the freezer and kept outside it absorbs heat from the surrounding and melts into water. When melting takes place, there is no change in temperature until the entire process is complete. The temperature at which the solid melts is called its melting point.

Boiling or vaporisation

It is the change of state from liquid to gas by absorption of heat. When you keep heating a liquid it becomes hotter and hotter and finally changes to vapour at a fixed temperature. The fixed temperature at which a liquid changes to vapour is known as its boiling point.



Freezing or solidification

When we keep a tray of water in a freezer of our refrigerator, the freezing compartment removes heat from the water and it gets converted to ice. This change in state from liquid to

solid by liberation of heat is known as freezing or solidification. The fixed temperature at which the liquid changes to solid is called its freezing point.

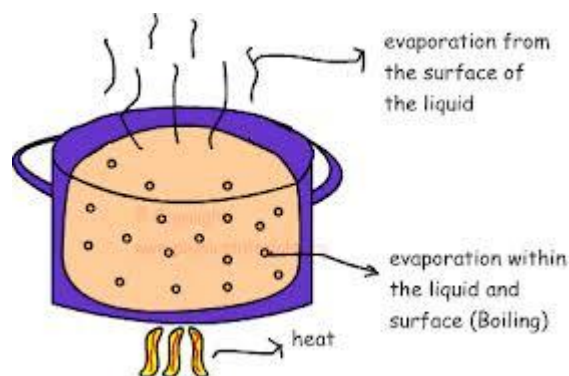
Condensation

It is the change in state from gas to liquid with the liberation of heat. Formation of clouds is due to the condensation of water vapour present in the atmosphere.

The fixed temperature at which the gas condenses to form liquid is called the condensation point.

Evaporation

It is the change of state from liquid to gas at a temperature below the boiling point. Evaporation is a reverse process of condensation. We obtain salt from salt water by evaporation. Drying of clothes in the sun is another example for evaporation.



Difference between boiling and evaporation

	Evaporation	Boiling
1	Takes place at the surface of the liquid	Takes place throughout the mass of the liquid
2	It takes place at all temperatures	It takes place at the boiling point
3	It is a slow process	It is a slow process
4	It is a silent process	It is a noisy process

Sublimation

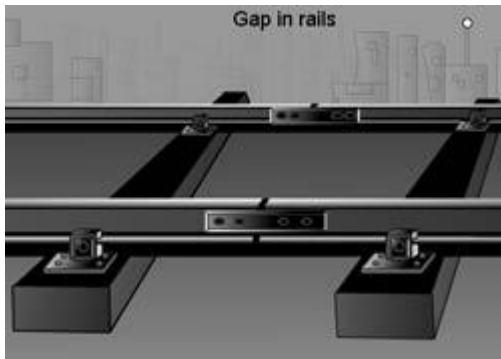
It is the change of state of a solid into gas directly without undergoing the liquid state. Some of the examples for are naphthalene, camphor and dry ice.

Thermal expansion

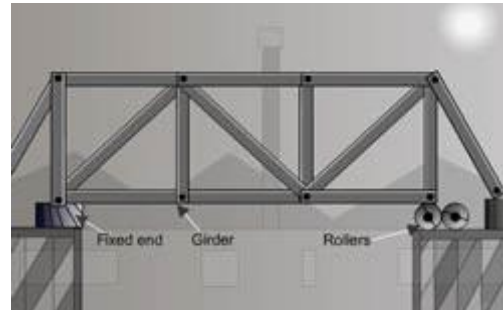
When a substance is heat, the molecules gain kinetic energy and move far apart. As a result the substance expands. Thus, the expansion of matter on heating is known as thermal expansion. Solids, liquids and gases expand on heating and contract on cooling. Expansion is the least for solids and the most for gases.

Expansion in solids

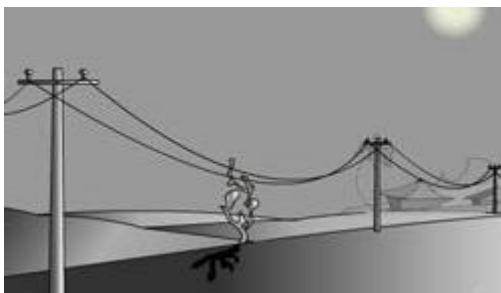
Thermal expansion finds a number of applications in our daily life. Some of the applications are listed below



Gaps are left in rails when railway tracks are laid to allow for their expansion in summer and contraction in



Bridges are laid on rollers to allow expansion in summer and contraction in winter

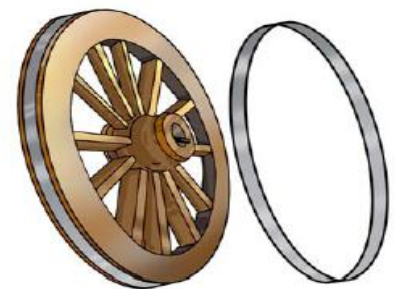


Telephone wires sag during summer and contract in winter so they are laid loose in winter to allow for contraction.



When hot water is poured into a thick glass tumbler it cracks. This is because the inner surface expands more than the outer surface. Due to uneven expansion the glass cracks.

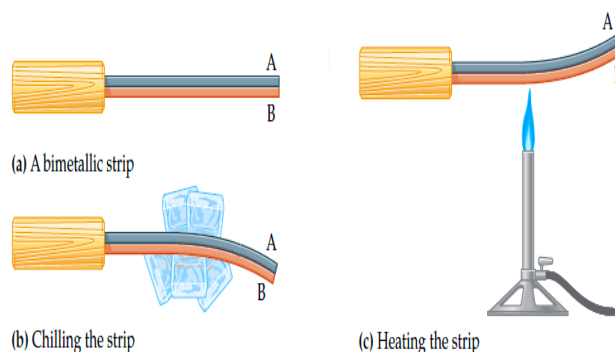
Thermal expansion is used for fixing the metal rim on a wooden wheel of a cart as shown in Figure. The metal rim is made slightly smaller than the wooden wheel. On heating, the rim expands and fits onto the wheel. Cold water is then poured over the rim, which contracts and fits tightly on to the wheel.



Bimetallic strip

When two different solids, which have different thermal expansion, are joined together, they form a bimetallic strip. Bimetallic strips are used in thermostat switches to control heat.

Thermostat switches are used in ovens, toasters, refrigerators.

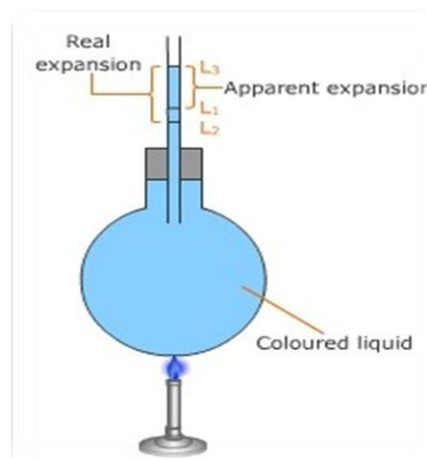


Expansion in liquids

All liquids expand on heating. Expansion in liquids is greater than expansion in solids. Different liquids expand at different rates.

A simple experiment can be conducted to demonstrate the thermal expansion in liquids.

Take a little amount of coloured water in a round bottom flask fitted with a one holed rubber stopper. Insert a thin glass tube and mark the initial level of water L_1 . Heat the water for a few minutes. Note the level of water L_3 . This shows that liquids expand on heating.



Expansion of gases

When gases are heated, its volume increases and it expands.

The expansion of gases can be demonstrated by the following activity. Fix a balloon to the neck of an empty glass bottle. Place the bottle in a bowl of hot water. You will observe that the balloon expands and blows up as shown in the figure. This shows that gases expand on heating.



Reference: www.goalfinder.com

www.it.iitb.ac.in/eshiksha/econtent