Chapter 5 Heat

Chapter Objectives

In this chapter, you will learn about:

- Heat as energy and its units
- Temperature scales
- Effects of heat
- The modes of heat transfer
- Conductors and insulators
- Construction and working of thermos flask

We use thermometer to measure body temperatures. Can you search about the normal human body temperature in degree Celsius and degree Fahrenheit scales?

INTRODUCTION

During summer, we like to eat something cold like cool-drinks, ice creams, etc. In winter, we use a heater to keep ourselves warm. On touching an ice cube, our hands feel cold. Many of us listen to weather reports, especially the temperature forecast. Thus, the terms hot, cold, temperature and warmth are related to our day-to-day life.

What is Heat?

We know that **heat** is a form of energy. Heat energy results from the motion of molecules of objects. The faster the molecules move in an object, the greater will be the heat energy.

The measure of heat energy present in an object is called temperature.

If we touch a cup having hot tea, we feel warm but while touching an ice cube, we feel cold. On touching a hot cup of tea, the heat energy transfers from the hot cup to our hands. Similarly, while touching the ice cube, heat energy moves from our body to the ice cube thereby melting it. Thus, *heat will always flow from the hotter object to the colder object until both the objects reach the same temperature.* Thus, we can define that *energy that transfers from one object to another due to difference in temperatures is called heat energy.* No further transfer of heat energy takes place if both the objects have attained the same temperature. This is known as **thermal equilibrium.**

UNITS FOR MEASUREMENT OF HEAT

Heat is energy, while temperature is the measure of that energy. The units of measurement of heat energy are given here:

Calorie: A calorie is the measure of heat energy. Calorie is the amount of heat required to raise the temperature of 1 g of water by 1 °C.

Kilocalorie: It is the amount of heat required to raise the temperature of 1 kg of water by 1 °C.

Equilibrium: A state in which two systems or objects are balanced

Joule: This unit is a smaller quantity of energy than calorie. Joule (J) is the SI unit of measuring heat energy.

1 Calorie = 4.18 Joules

INFO HUB

The unit calorie is also used to measure the energy content of foods.

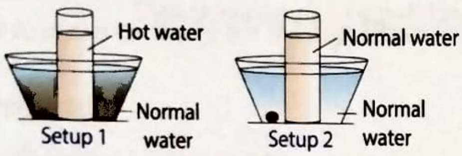
ACTION TIME 1

Aim: To show that heat energy transfers between objects that are at different temperatures.

Materials required: two water glasses, two glass bowls and two gem chocolates

Procedure:

- Set up two arrangements as shown in the picture.
- Seek an adult to prepare hot water and handle it.
- Place a piece of chocolate in each of the bowls. Leave the setup for 10 minutes. Observe what happens to the chocolates.



Answer the following questions based on your observation:

- Where does the chocolate melt quickly? Why?
- What is the purpose of having setups in this experiment?

Quick Check 1

Fill in the blanks.

1. Heat energy always flows from .... objects to .... objects.
2. The measure of heat energy of an object is called ....
3. The SI unit of measuring heat energy is ....
4. A .... is the amount of heat required to raise the temperature of 1 g of water by 1 °C.
5. .... is the energy while temperature is the measure of heat energy.

TEMPERATURE

Temperature is the measure of degree of hotness or coldness of an object. For example, if an object has a temperature of about 70 °C, we can say that it is hot and if an object has a temperature of about 2 °C, it is considered to be cold.

Temperature is commonly measured in degree Celsius (°C) and degree Fahrenheit (°F). The SI unit of temperature is kelvin (K).

Measuring Temperature

When a substance is heated, the molecules in it move faster than before. This causes an increase in its temperature. These fast moving molecules hit each other and move further apart from each other than they were before. This causes a slight expansion in the volume of the substance. There are devices that use this expansion of substances as a measure of temperature. Such devices are called **thermometers**.

Fig. 5.1 Taking reading with a mercury thermometer

TEMPERATURE SCALES

A thermometer is calibrated for different types of **temperature scales.** The temperature scales that are commonly used are Celsius scale, Kelvin scale and Fahrenheit scale.

To calibrate a thermometer for a temperature scale, first we have to choose two fixed points, one for the lowest temperature and the other for the highest temperature.

In some commonly used temperature scales, fixed points are defined using the following properties of pure water:

The lower fixed point indicates the temperature of pure melting ice at normal atmospheric pressure. It is taken as 0 °C. The upper fixed point represents the temperature of pure boiling water at normal atmospheric pressure. Its value is 100 °C.

Once we have two fixed points, the number of subdivisions are calculated.

Celsius Scale

In Celsius scale, the lower and upper fixed points represent 0 °C and 100 °C, respectively. The length of thermometer between these fixed points represents 100 °C. If one small division is taken to mark 1 °C, there will be 100 subdivisions in between the lower and upper fixed points. In order to study Kelvin and Fahrenheit scales, it is worth knowing the relationship between Celsius, Fahrenheit and Kelvin.

Relationship between Celsius, Kelvin and Fahrenheit scales

We can relate Celsius, Kelvin and Fahrenheit scales using the following formula:

$$\frac{C}{100} = \frac{F - 32}{180} = \frac{K - 273}{100}$$

Kelvin Scale

Using the above relationship, we can convert Celsius scale into Kelvin scale:

$$C = K - 273 \text{ or } K = C + 273$$

$$0\,^{\circ}\text{C is equivalent to: } K = 0 + 273 = 273\text{ K}$$

$$100\,^{\circ}\text{C is equivalent to: } K = 100 + 273 = 373\text{ K}$$

Hence, the lower fixed point in Kelvin scale represents 273 K and the higher fixed point indicates 373 K.

So, the length between the two fixed points represents (373 – 273) K or 100 K. If one small division is considered to mark 1 K, there will be 100 subdivisions in between the lower and upper fixed points.

Teaching Tip: Discuss with students about the temperature scale they use to measure the body temperature.

Calibration: Setting or adjusting of a measuring device

Fahrenheit Scale

Using the formula, we can convert Celsius scale into Fahrenheit scale:

$$\frac{C}{100} = \frac{F - 32}{180}$$

$$\therefore C = \frac{F - 32}{1.8} = \frac{5}{9}(F - 32)$$

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

0°C is equivalent to: $F = \frac{9}{5} \times 0 + 32 = 32\ °F$

100°C is equivalent to: $K = \frac{9}{5} \times 100 + 32 = 212\ °F$

Hence, the lower fixed point in Fahrenheit scale represents 32 °F and higher fixed point indicates 212 °F.

So, the length between the two fixed points represents (212 – 32) °F or 180 °F. As each small line is marked to indicate 1 °F, there will be 180 subdivisions in between two fixed points.

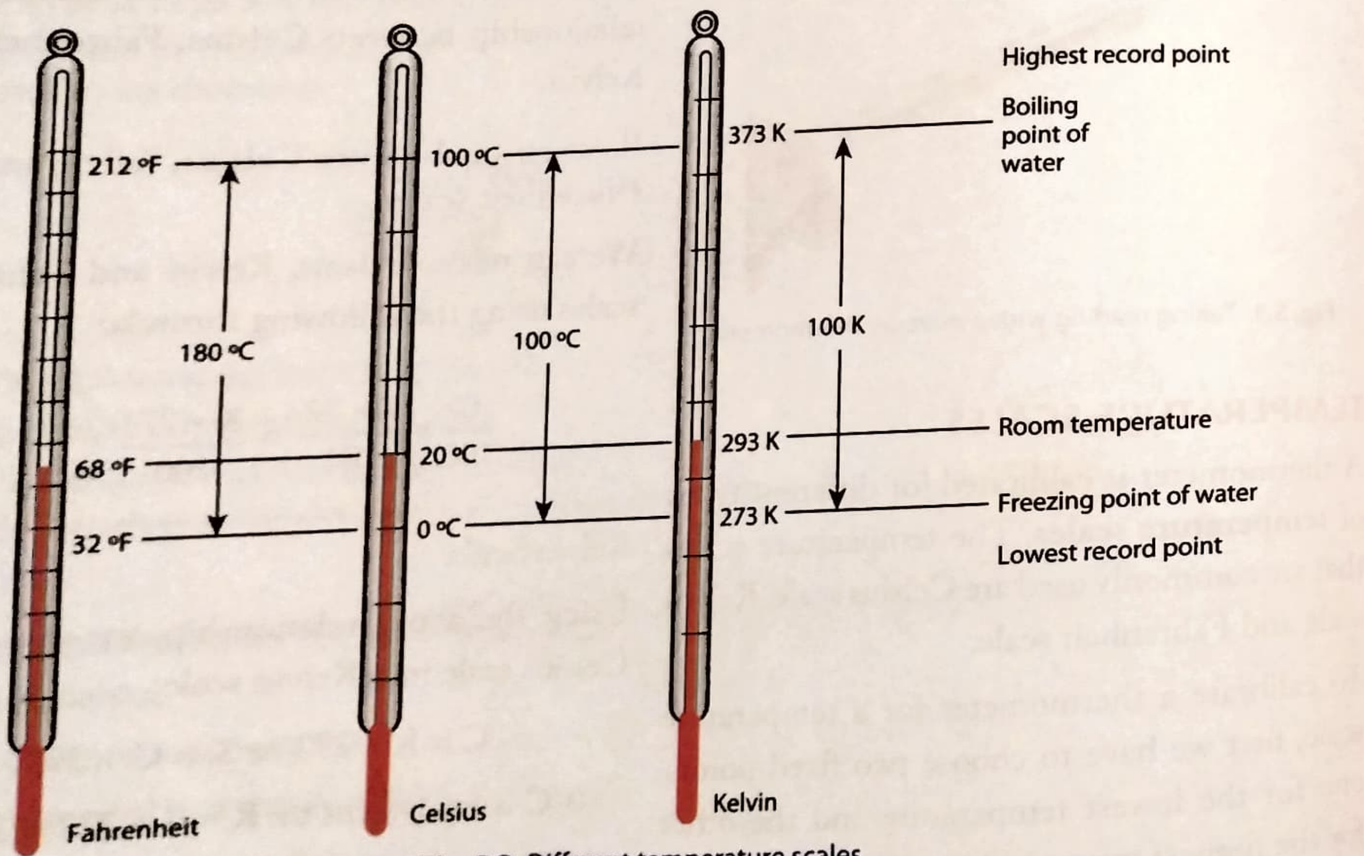


Fig. 5.2 Different temperature scales

NUMERICALS

1. In a thermometer, if the difference between temperatures marked by two long lines is 5 °C, and there are 5 small lines in between, how much temperature does each subdivision read?

Solution:

Temperature indicated by each subdivision = $\dfrac{\text{Temperature indicated by two successive long lines}}{\text{Number of subdivisions}}$

$$= \frac{5}{5} = 1\ °C$$

2. Convert 90 °F to °C.

Solution:

Use the following formula,

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

$$= \frac{5}{9}(90 - 32)$$

$$= \frac{5}{9} \times 58$$

$$= 32.2°C$$

3. At what temperature is the reading on the Fahrenheit scale five times the reading on the Celsius scale?

Solution:

Use the following formula,

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

Let us substitute $C = x°C$; $F = 5x\ °F$

$$\therefore \quad \frac{x}{5} = \frac{5x - 32}{9}$$

or $\quad 9x = 25x - 160$

or $\quad 16x = 160$

$$\therefore \quad x = \frac{160}{16}$$

$$= 10°C$$

The temperature in Fahrenheit scale is $5x = 5 \times 10 = 50\ °F$.

INFO HUB

The underside of the tongue has lots of blood vessels. Hence, it is one of the few places that exhibit the accurate temperature of our internal body. Therefore, by keeping the thermometer below the tongue, we can measure the accurate body temperature.

Table 5.1 Temperature in kelvin, degree Celsius and Fahrenheit

Scale	Boiling point of water	Freezing point of water
°C	100	0
°F	212	32
K	373	273

Quick Check 2

Give one word answer for the following:

1. What is the term used to measure the degree of hotness or coldness of an object?
2. What is the SI unit of temperature?
3. What is the boiling point of water in °C?
4. What is the lowest record point in a Kelvin scale?
5. What is used to measure temperatures?

ACTION TIME 2

Aim: To understand how expansion and contraction help the functioning of a thermometer.

Note: This experiment should be done under adult supervision as you will have to handle hot water.

Materials required: an empty glass bottle, modelling clay, marker, dropper, hot water, cold water, normal water, food colour, white index card, few drops of vegetable oil

Procedure:

- Fill the glass bottle up to the bottom of its neck with normal water.
- Add a few drops of food colouring to the water in the bottle.
- Place a straw into the bottle. Pack clay around the straw and bottle neck. Make as tight a seal as possible.
- Attach a white index card to the top of the straw.
- Carefully add a few drops of coloured solution into the top of the straw.
- Use your dropper to carefully add a single drop of vegetable oil into the straw. Use only one drop.
- Mark the initial level of water column.
- Now that you have made your thermometer, set the bottom of the bottle into the container of cold water. What happens to the water inside the straw? Mark the level.
- Put the thermometer into the container of hot water (not too hot). What happens to the water inside the straw this time?

What do you infer from your observation?

How do you compare your thermometer with a mercury thermometer?

How will you improvise your model to measure the exact temperature of an object in degree Celsius?

EFFECTS OF HEAT

When heat is added to an object, it will cause one or more of the following effects.

- Change in temperature
- Change in size of the body
- Change in state

Change in Temperature

When an object is heated, its temperature increases. On the other hand, the temperature of the object decreases when it is cooled.

The change in temperature depends on the mass of the object, nature of the material and amount of heat supplied to or withdrawn from the object.

Change in Size (Expansion and Contraction)

When an object is heated, the molecules move faster and further apart. This causes an increase in the size (length, area or volume) of the substance. Similarly, when an object is cooled, the molecules move slowly and are closer together. Hence, the volume of the substance decreases. *The increase in size or volume of a substance when it is heated is called thermal expansion and the decrease in its size or volume due to decrease in temperature is called contraction.*

An example of expansion includes the power transmission lines that sag during summer. This is because they expand during summer and their length increases which causes them to sag.

Change in State

The main three states of matter are solid, liquid and gas. One state of matter can be converted into another state by heating or cooling. For example, while boiling the water, the liquid is converted into steam which is a gas.

There are different physical processes which can convert matter from one state to another. Let us see these processes in the following sections.

When a solid is heated, it absorbs heat and its temperature rises. At certain constant temperature, the solid starts to change into liquid. Until the entire solid converts into liquid, the temperature does not rise. *The process during which a solid changes into liquid state at fixed temperature, by the absorption of heat, is called fusion or melting.*

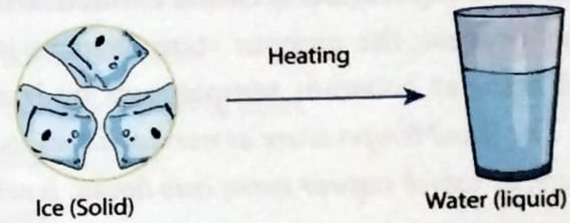


Fig. 5.3 Solid ice changes into water on heating

Inverse of melting is called **freezing or solidification** that changes liquid into solid state at constant temperature by losing heat. *The fixed temperature at normal atmospheric pressure, at which the liquid turns into solid, is called freezing point.*

Freezing point and melting point are the same for the same matter. For example, ice melts at 0°C and water freezes at 0°C.

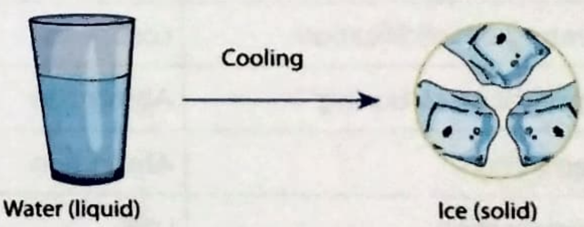


Fig. 5.4 Liquid water changes into solid (ice) on freezing

On heating, a liquid absorbs heat and becomes warm. *At a certain temperature, the liquid changes to gaseous state by the absorption of heat. This is called vaporisation or boiling.*

Sag: Bulge downward

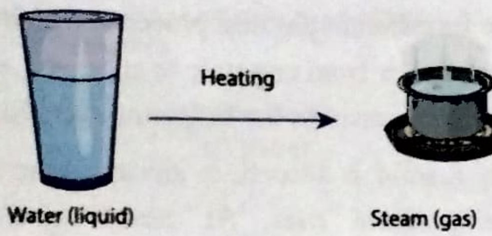


Fig. 5.5 Liquid changes into gas

Liquid can convert itself into gas even below the boiling point by absorbing heat. Thus, *the process at which liquid changes into gaseous state below its boiling point is called evaporation.*

Inverse of evaporation is called condensation. In this process, the gaseous state changes into liquid state at constant temperature by losing heat. *The fixed temperature at normal atmospheric pressure, at which vapour turns into liquid, is called condensation point.*

On absorbing heat, certain solids change their states directly to gas without undergoing through liquid state. This process is called sublimation.

For example, dry ice (frozen CO_2) directly changes into gas when it is heated. Other examples are naphthalene, iodine, ammonium chloride and so on.

On cooling, some gases directly change into solid state. This process is called deposition. Examples include conversion of carbon dioxide into dry ice.

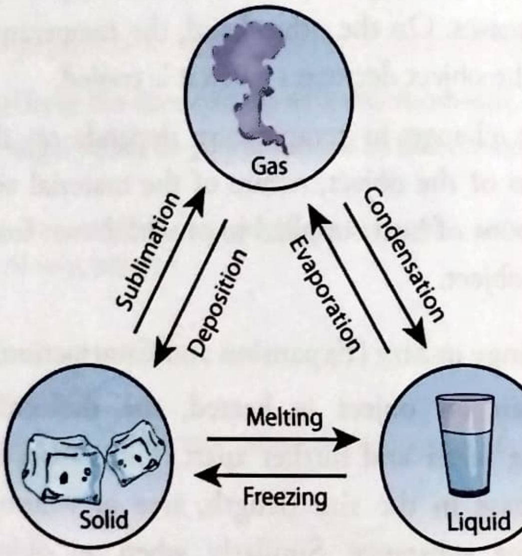


Fig. 5.6 Changes in states of matter

Table 5.2 Change of states of matter due to absorption or loss of heat

Process	Heat absorption/loss	Change in state
Fusion or melting	Absorption	Solid into liquid
Freezing or solidification	Loss	Liquid into solid
Vaporisation or boiling	Absorption	Liquid into gas at boiling point
Evaporation	Absorption	Liquid into gas below its boiling point
Condensation	Loss	Gaseous state into liquid
Sublimation	Absorption	Solid into gas
Deposition	Loss	Gas into solid

INFO HUB

There is a fourth state of matter called 'plasma', which is an ionised gas. It exists around the stars, including the Sun and throughout interstellar space. Scientists have estimated that more than 99% of matter in the universe exists in the plasma state. Compact fluorescent light that we use for lighting our house, functions due to the existence of plasma.

Quick Check 3

A. Give one word answer for the following.

1. Name the process in which conversion of gas into solid takes place. ....
2. Name the process in which liquid is changed into solid below boiling point. ....
3. In condensation, which state of matter is converted into liquid? ....
4. Name the process in which solid changes into a liquid. ....
5. At freezing point, water changes to this. ....

B. State whether the following statements are True or False.

1. The temperature of an object increases when it is cooled. ....
2. The change in temperature depends on the mass of the object. ....
3. The conversion of carbon dioxide into dry ice is called condensation. ....
4. During sublimation, heat energy is absorbed. ....
5. During condensation, heat energy is released. ....

THERMAL EXPANSION

When materials are heated, their size and volume increase as they absorb heat. *The expansion in matter due to absorption of heat is known as thermal expansion.*

On heating, the molecules of substances move faster and collide with each other and eventually move far apart from each other. This causes the substance to expand.

Solids expand little on heating as the particles are closely packed. The particles are loosely bound in liquids, hence they expand more than solids. In a gas, the molecules are free and hence, they expand the most on heating.

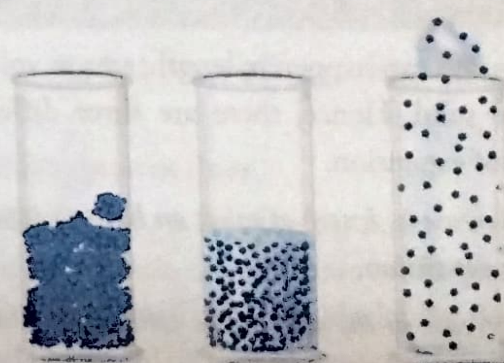


Fig. 5.7 Molecules in solids, liquids and gases

ACTION TIME 3

Aim: To show thermal expansion in solids by Gravesand's ring and ball experiment.

Materials required: an iron ball, an iron ring, a metal stand and a burner

Procedure:

- Take the metal ball and the metal ring. The diameter of the ball should be such that it just passes through the ring. Check this out by passing the ball through the ring.
- Heat the ball for some time over a burner.
- Now, try to pass it through the ring. What do you observe?
- Allow the ball to cool and try passing it through the ring. What do you observe?

Observation and conclusion: It is observed that the ball does not pass through the ring when it is heated. It shows that the iron ball has expanded when it is heated. However, when the ball is cooled, it regains its original size and can pass through the ring easily.

ACTION TIME 4

Aim: To prove that lengths of different solids expand by different amounts when heated.

Materials required: a bimetallic strip (a strip where two different materials are riveted together firmly) and a burner

Procedure:

- Heat the bimetallic strip for 5 minutes using burner.

Observation and conclusion

It is observed that the strip is bent such that the brass is at the outer surface of the curve. At the same time, iron is on the inner side of the curve. It shows us that different metals expand at different rates when they are given equal amount of heat. **Brass expands more than iron on heating**.

a. At room temperature

b. On heating

Expansion in Solids

Expansion can happen in length, area or volume of the solid. Hence, there are three different types of expansion.

The increase in length of solids on heating is called ***linear expansion.***

The increase in the area of the solid on heating is called superficial expansion.

The increase in volume of a solid on heating is called cubical expansion.

Applications of Thermal Expansion in Solids

Construction of bridges

Metal girders used in bridges expand during summer and contract during winter. It may cause structural damage to the bridge. In order to avoid this, while constructing a bridge using iron girders, some space is left for the metal to expand with rise in temperature. Thus, one **end of the girders is fixed and the other end is placed over iron rollers so as to allow the** metal to expand and contract without causing any damage.

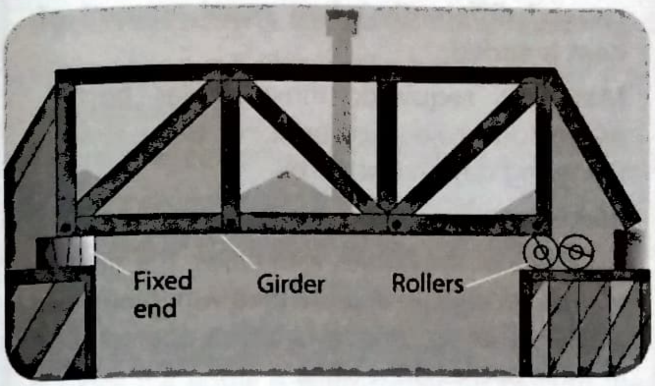


Fig. 5.8 Rollers in bridges allowing the metal girders to expand or contract

Fixing iron rim on the wooden wheel

In a bullock or horse cart, the wheels are made up of wood. The rim of the wheel is made up of iron. The radius of the iron rim is slightly less than that of the wooden wheel. First, the iron rim is heated to red hot, so that it expands and its radius increases. It is then fitted over the wooden wheel. Finally, cold water is poured on the wheel so that the iron rim contracts and gets tightly fixed to the wooden wheel.

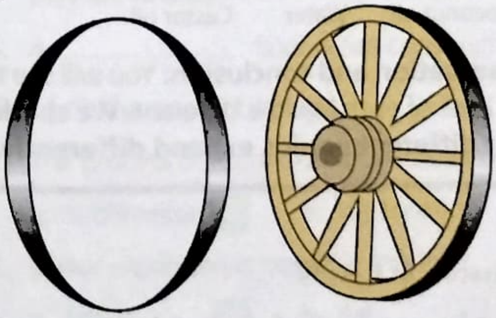


Fig. 5.9 A wooden wheel is attached to the iron rim using the property of thermal expansion

Laying railway tracks

Rails are commonly made up of iron or steel. During summer, the iron expands and if there is no space for expansion, the railway track would bend outwards. This will result in derailment of trains.

To avoid derailment, while laying the railway tracks, a small gap is left between the rails.

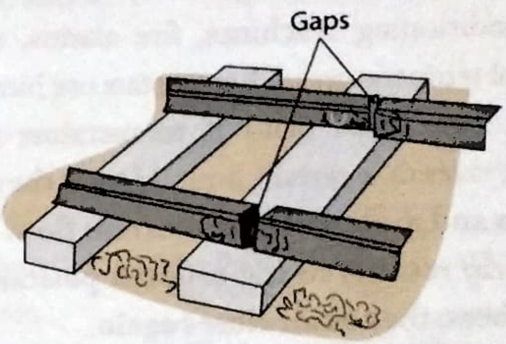


Fig. 5.10 A gap is left between two adjacent rails

Sagging telephone and electric wires

Telephone and electric wires are made up of metals and hence, they tend to contract in winter. This may break the wires. In order to prevent any damage from occurring, the wires are kept slightly loose so as to allow contraction during winter.

Fig. 5.11 Sagging in transmission lines

Building cement floor

A cement floor is not constructed as one block, as it may crack during summer. Instead, it is built using small concrete blocks. By doing so, a small gap is left between two adjacent blocks which enables the blocks to expand. Thus, the crack in the floor can be avoided.

Derailment: A train or a trolley car leaving its tracks accidentally

Using bimetallic strips in thermostat

Thermostats are used in electrical appliances such as geysers, refrigerators, electric irons, air conditioning machines, fire alarms, etc., to control temperatures. Thermostats use bimetallic strips. The strips bend if temperature in the circuit exceeds a certain limit. Hence, **the circuit breaks and there will be no current flow. When the strip returns to the original position as it loses heat, the circuit closes again.**

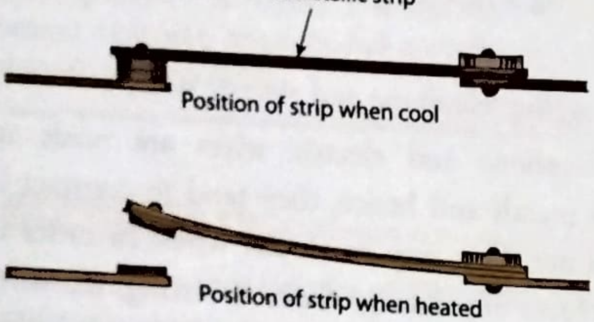


Fig. 5.12 Bimetallic strip used in thermostat

> **INFO HUB**
>
> On pouring boiling water or ice into an ordinary glass tumbler, it cracks.
> It is because glass is a bad conductor of heat and therefore, inner and outer surfaces of the tumbler expand differently. This is why a glass tumbler cracks when hot or cold water is poured.

Expansion in Liquids

Liquids undergo cubical expansion on heating. It means the volume of liquid increases on heating. However, the volumes of different liquids change to different extents. Let us perform an activity to understand the same.

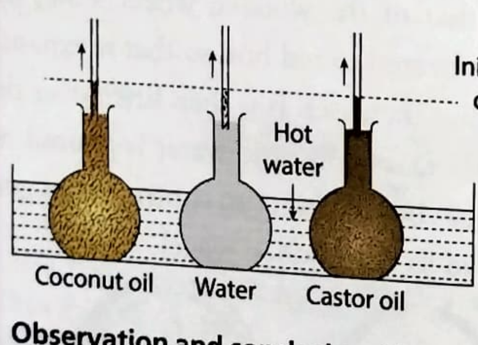
ACTION TIME 5

Aim: To understand that different liquids expand differently when equal amount of heat is added.

Materials required: three similar bottles, water, food colour, coconut oil, three straws, modelling clay and castor oil

Procedure:

- Fill one of the bottles with water, the second with coconut oil and the third with castor oil. Make sure the volume of liquids poured in all three bottles is the same.
- Place a straw in each bottle and pack clay around the straw and bottle neck.
- Pour hot water in a wide container.
- Place all three bottles into the container as shown.
- Leave the setup for 5 minutes.
- Observe the level of each liquid inside the straws.



Observation and conclusion: You will see that the level of each liquid is different. We conclude **that different liquids expand differently.**

Expansion in Gases

Gases do not have definite shape or volume. **When gases are heated, their volume increases.** On heating, gases expand the most.

ACTION TIME 6

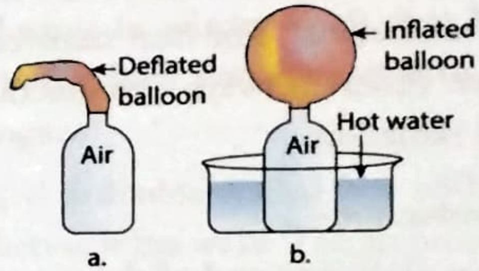
Aim: To understand that air expands on heating.

Note: This activity should be done under teacher's observation.

Materials: two balloons, two bottles, a bowl and hot water

Procedure:

- Stretch the opening of the balloon around the open end of each bottle.
- Pour hot water into the container.
- Set one of the bottles on the hot water.
- Give the bottle and balloon apparatus 5 minutes to get warm.
- Observe the change in the size of the balloon after 5 minutes.
- Once the bottle is warm, what happens to the balloon attached with both the bottles?



Observation: You will observe that the balloon connected with the bottle that is kept in the hot water inflates.

Conclusion: The **gas expands when it is heated.**

Quick Check 4

A. Fill in the blanks.

1. .... expands more than .... and .... on heating.
2. Different liquids expand .... when heated equally.
3. Increase in the .... of an object when it is heated is called cubical expansion.
4. .... and .... expansions are not possible in gas and liquid when they are heated.
5. A .... floor is not constructed as one block, as it may crack during summer.

B. Tick (✓) the correct option.

1. The process of expansion of materials on heating is known as:
   a. sublimation ☐ b. vaporisation ☐ c. contraction ☐ d. thermal expansion ☐
2. Linear expansion is possible only in:
   a. liquid ☐ b. gas ☐ c. solid ☐ d. all of these ☐
3. Which of the following metal strips is used in thermostats?
   a. Iron ☐ b. Copper ☐ c. Bimetallic ☐ d. Brass ☐
4. Which of the following materials shows resistance to uneven expansion on heating?
   a. Wood ☐ b. Borosil glass ☐ c. Ordinary glass ☐ d. None of these ☐
5. Which of the following expands the most on heating?
   a. Solids ☐ b. Liquids ☐ c. Gases ☐ d. None of these ☐

Convection

Convection is the process of transfer of heat in liquids and gases where the actual movement of particles of matter occurs.

Heat transfer through convection is possible only in liquids and gases, and not in solids. In solids, molecules are closely packed and therefore, the molecules do not move in order to transfer heat. But in liquids and gases, molecules are free to move. Exception is mercury, as it transfers heat only through conduction, even though it is liquid.

Let us demonstrate convection in liquids through the following experiment.

ACTION TIME 9

Aim: To demonstrate heat transfer through convection in liquids.

Materials required: a round bottom flask, food dye, dropper (pipette), burner, wire gauze and cold water

Procedure:

- Fill the round bottom flask with cold water.
- Take a little food dye into the pipette, then very slowly and carefully, lower the pipette into the water and deposit a pool of food dye at the base of the flask.
- Slowly remove the pipette from the round bottom flask, so as not to disturb the water.
- Heat the water using a very small flame under the pool of food colour.

Observation and conclusion:

After a minute, you will see streams of food dye starting to flow upwards from the pool. The moving dye spreads out after moving some distance. This is because, on heating, the molecules in contact with the base of the round bottom flask heat up first. As they gain heat, they expand and become light. The less dense matter moves upwards and spreads out. Simultaneously, molecules at the top move downwards. Thus, the molecules near the bottom of the beaker displace the molecules that are at the top. Thus, convection currents are set up in water.

Application of convection currents

1. People living in coastal areas experience sea breeze and land breeze as a result of convection currents.

During the day, land gets heated faster than the sea. The air over the land becomes hotter and lighter, and hence rises. The cooler air from the sea moves towards the land to take its place. At the same time, the warm air from the land moves towards the sea to complete the cycle. **The air from the sea is called sea breeze.**

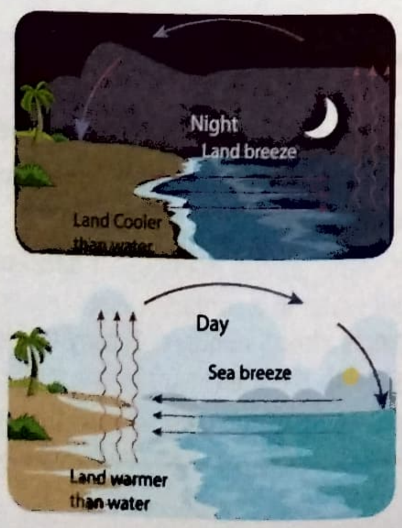


Fig. 5.14 Land breeze and sea breeze

At night, water loses heat more slowly than land. The cool air from the land moves towards the sea. This is called **land breeze.**

2. The temperature inside a room will keep increasing as the people exhale more carbon dioxide creating suffocation in the room. To remove the unnecessary heat from the room, ventilators are placed high up on the walls of the room. Hence, **the warmer air rises up and escapes through ventilators and cooler fresh air flows in the room through doors and windows.**

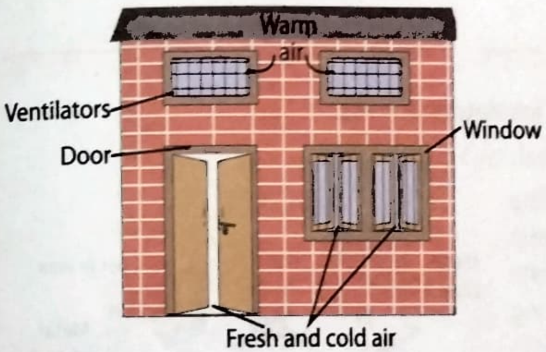


Fig. 5.15 Ventilation in homes

3. In refrigerators, the freezer is always placed at the top, so that the cool air at the top will move to the bottom and warm air at the bottom rises up to the top. Thus, it keeps the refrigerator cool.
4. In industries, smoke and gas being hot, rise up and escape through chimneys.
5. When the ground gets heated, hot air rises from the ground. It lifts the hang gliders in the air, so that they fly without any energy to push them. This is how birds use the air current to fly without spending more energy.

Radiation

We now know that in conduction and convection, the particles of matter transfer the heat. However, the heat from the Sun reaches us after passing through space which is merely vacuum. So, there must be another mode of heat transfer which does not involve the particles of the medium.

The mode of heat transfer in which heat is transferred from hot objects to cold objects, without directly heating the space in between, is called radiation. Radiation is different from convection and conduction as it does not require any medium.

Objects which are hotter than their surroundings radiate heat, called **radiant heat.** For example, bulbs, fire, Sun and electric room heater radiate heat.

Like light waves, heat radiation travels in a straight line and can be reflected and absorbed.

Absorption and reflection of radiant energy

The important points are as follows:

- Dark-coloured objects or **objects that are black, are good absorbers and good radiators of heat.**
- Objects that have a shining surface or **objects that are white in colour are poor absorbers and poor radiators of heat.**

Applications of radiation

Black and Polished Surface

1. Cooling fins at the back of a refrigerator are rough and black. It is because the fins that are black will quickly radiate heat energy to the surroundings.

Suffocation: To die because of not having enough oxygen

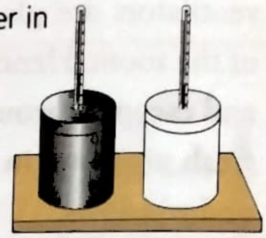
ACTION TIME 10

Aim: To show how colours of an object determine the absorption and reflection of radiant heat.

Materials: two silver containers, black papers, white papers and two thermometers

Procedure: Take two glass containers and pour the same amount of water. Cover the outer walls of one container and its lid with black and that of another with white sheets. Insert a thermometer in each can by making a hole at the centre of the lids. Note down the initial temperature of the water in both the containers. Place them in sunlight for 20 minutes. Note the temperature reading by each thermometer.

Observation: You will infer that there is a greater rise in the temperature of water in the black container than that in the other.



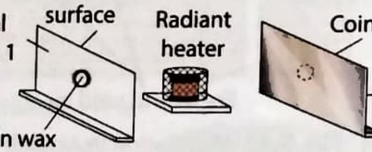
Conclusion: A black object is a better absorber of heat and the white object is a better reflector of light.

ACTION TIME 11

Aim: To understand that silvery surfaces are good insulators of heat.

Materials: two shiny metal plates, wax, a source of heat, two coins

Procedure: Take two metal plates. Cover one side of a plate with black paper or paint it in black colour. Place the two plates vertically so that the black side of one metal plate faces another metal. Place two coins on the sides, facing outside of each plate using wax. Place the source of heat in between them exactly in the middle.



Observation and conclusion: You will observe that the coin that is attached with the metal plate 1 falls first. This shows that **shiny bodies are not good absorbers of radiant heat.**

2. In hot countries, houses are painted in bright or white colour to reduce heat absorption.
3. A teapot has a smooth and shiny silvery surface to reduce heat loss. As a result, tea or coffee can be kept warm for a longer time.

Fig. 5.16 A teapot having a shiny surface

INFO HUB

During a sunny day, we would like to stand in the shade of a tree. This is because as the heat radiations travel in a straight line, the tree blocks some radiations and thus, on standing under a shade, we will not feel more heat as in our surroundings.

Thermos Flask or Thermos

A thermos flask is a double-walled glass or metal container. Air in the space between the walls is pumped out and sealed near the neck or foot of the container. Hence, the space between the walls is almost empty. The inside surfaces of the double-walled glass containers are made of silver.

The flask is then placed in a metal or plastic case and is secured at the neck. The mouth of the container is closed by a stopper made of a bad conductor of heat.

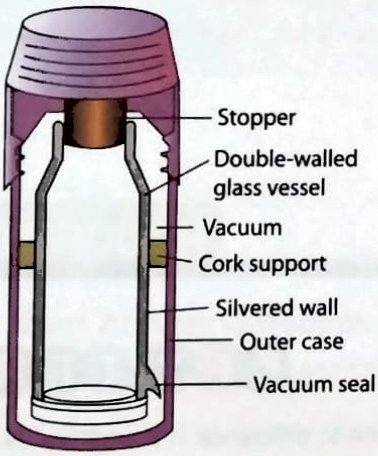


Fig. 5.17 Thermos flask

Working

The features of a thermos flask effectively reduce the heat transfer between the outside and inside of the container. ***The vacuum between the glass walls prevents heat transfer by conduction.*** The tight stopper prevents air from entering or leaving the flask, so convection is not possible either.

However, radiation is possible even if there is no medium between the glass walls. When heat radiation tries to enter or leave the flask, the silvered surfaces of glass reflect it straight back, and thus, reduce heat exchange due to radiation.

As a result of all these, a hot drink stored in a thermos will stay steaming hot for several hours. Similarly, substances that are cold, stay cold inside a thermos flask.

INFO HUB

Polar bears have white fur and black skin.

Polar bears live in cool environments and have thick fur to trap more air and keep themselves warm. Fur even grows at the bottom of their paws, which protects against cold surfaces and provides a good grip on ice. But under their white fur, polar bears have black skin that absorbs heat energy from the Sun.

Quick Check 5

A. Tick (✓) the correct option.

1. During summers, we should wear .... clothes.
   a. black ☐ b. maroon ☐ c. white ☐ d. grey ☐
2. Heat is transferred through conduction in:
   a. solids ☐ b. liquids ☐ c. gases ☐ d. all of these ☐
3. .... is the process of transfer of heat in liquids and gases, where the actual movement of particles of matter occurs.
   a. Convection ☐ b. Conduction ☐ c. Contraction ☐ d. Condensation ☐