15 Temperature and Heat

Points to be Studied

15.1 Meaning of temperature
15.2 Measurement of temperature
15.3 Meaning of heat
15.4 Heat circulation methods
- Conduction
- Convection
- Radiation

Every day we come across a numbers of objects. Some of them are hot and some cold. List the names of some objects in next table 15.1. Mark these as hot or cold.

Table 15.1

Sr. No.	Object's Name	Hot or Cold
1	Ice	Cold
2		
3		
4		
5		

Generally how do you decide that the object is hot or cold? We often do it by touching the objects. But is our sense of touch reliable to know about the hot or cold objects? Let us find out.

15.1 Meaning of temperature

Activity 1

Take three big containers like a bucket, a stainless steel pot. Put ice mixed cold water in first pot A , normal water in second pot B and warm water in third pot C. Now dip your left hand in pot A and the right hand in pot C. Now take out both the hands and put them immediately in pot B (see fig 15.1).

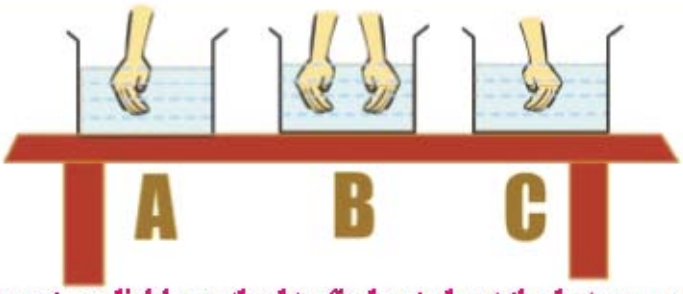


Figure 15.1 Touch is not a reliable method to find out about the hotness or coldness of objects.

What do you feel? Whether water in pot B is hot or cold? Your left hand feels hot water and the right hand feels cold water. You are unable to decide whether water in pot B is cold or hot. This experiment proves that our sense of touch is not reliable to know about the hotness or coldness of objects.

Then, how do we find out how hot an object really is? The hotness or coldness of an object can be known by a characteristic called the temperature of an object. Temperature of an object is measured by a device called thermometer.

We do not use the words cold or hot for an object. But we say that the object has high temperature or low temperature. The hotness or coldness of an object displays a comparative state of temperature. For example - temperature of ice is low as compared to that of lukewarm water but the temperature of boiling water is more as compared to both ice and lukewarm water.

15.2 Temperature measurement

Temperature of an object is measured by a device which is called thermometer. There are many types of thermometers e.g., laboratory thermometer, gas thermometer, alcohol thermometer, digital thermometer, etc. In this chapter we will study about laboratory thermometer and clinical thermometer.

(A) Laboratory thermometer

Activity -2

Observe carefully the thermometer available in your school. It is a long glass tube with a thin internal glass tube of equal diameter filled with mercury. One end of the tube is joined with bulb and other end is closed. Thermometer has printed scale on which is generally a Celsius scale. In Celsius scale, temperature is expressed in °C (degree Celsius). Observe the thermometer carefully, and find out the highest and lowest scale value on it.

In the laboratory thermometer, normally -10°C to 110°C markings are seen. It is called the range of thermometer. How is temperature measured by a thermometer?

Figure 15.2 Laboratory thermometer

Let us do and observe

As in earlier activity, dip the bulb of thermometer in pots A, B and C filled with water one by one and wait till mercury surface level becomes stable. Note the readings on the thermometer.

Be careful that bulb of thermometer does not touch the bottom and sides of pot. Also keep in mind to place the thermometer in erect/ vertical position, not in inclined position and note the reading by keeping the eye parallel to the mercury level

(B) Clinical thermometer

The thermometer which is used to know the temperature of our body is called **Clinical** thermometer. It has two scales marked, one Celsius and another Fahrenheit. Its glass tube is also filled with mercury. Observe the clinical thermometer carefully. Outside the bulb, a fine and shining line along the tube is seen. If you are not able to see the line, then rotate the thermometer slightly and then see the fine line.

The clinical thermometer is designed to measure the temperature of human body only which is between 35°C to 42°C. Thus the temperature range of clinical thermometer is between 35°C to 42 °C. This range in Fahrenheit scale is between is 94-108 °F. The normal temperature of human body is 37°C or 98.6°F. In fever the temperature of the body increases.

Fig 15.3 Clinical thermometer

How do we find the body temperature from clinical thermometer?

Let us see by doing

Activity-3

Take a clinical thermometer and put the bulb of thermometer under the tongue inside mouth and hold it there for some time and then take it out. Now, see the mercury level and note the reading in your notebook.

Wash the thermometer, with an antiseptic solution and measure the body temperature of another student. Repeat the procedure for other students in your class and note down the readings in table 15.2. The mercury level neither rises nor drops in clinical thermometer after taking it out from mouth. It is due to the presence of a kink near the bulb which does not let the mercury level to drop or rise by itself. So, each time before taking the temperature it is held firmly in hand and a few jerks are given so that the level of mercury goes down.

Table 15.2

Sr. No.	Student's Name	Temperature
1		
2		

It is not necessary that body temperature of each student is 37°C. It could be slightly higher or slightly lower. Actually, the normal temperature of a healthy body is the average body temperature of a large number of people. This average temperature is 37°C.

Precautions:

The bulb of thermometer should not be put directly on a flame or near a flame or in sunlight for longer period of time as it may break.

Also know it.

Figure 15.4 Maximum-minimum thermometer.

Figure 15.5 Digital thermometer.

Maximum - minimum thermometer

The different thermometers are used for different applications. It is used to provide the maximum and minimum temperature in weather reports.

Digital thermometer

Mercury is a toxic material and if a thermometer breaks and its mercury litters, it may be harmful to the body if any kind of intake occurs. So, nowadays, digital thermometer is in common use.

15.3 Meaning of Heat

Heat is a form of energy which can be transferred from one object to another. Due to heat transfer the objects either become hot or cold i.e., their temperature either increases or decreases. Why does this happen?

Let us see by doing.

Activity-4

Take 1.5 - 2 litre water in a stainless steel pot or other container and warm it till boiling. Now, remove the pot from the flame. Take water with normal temperature in a glass or test tube and measure its temperature. Now, put the test tube or glass into the hot water pot for some time and again measure the temperature. What is the difference in both temperatures?

You will find that the temperature cold water rise and temperature of hot water decreases a little. Thus

"Heat flows from the object with high temperature towards object with low temperature."

"The temperature of the object which releases heat becomes low whereas the temperature of the object which receives heat becomes more."

Find out the temperature of both water containers after one hour. You will find that temperature in both the water containers is the same.

"The hot or cold objects exchange heat till the temperature of both becomes the same."

You have seen that heat is transferred form one object to another. What are the methods for heat transfer? Let us discover.

15.4 Methods of Heat transfer

(A) Heat Transfer through conduction

Activity-5

Take a broken cycle spoke or thin straight iron wire and paste a few pieces of wax at equal distance on it. Put one end of wire on a table, put a brick or stone on it under the brick or stone as shown in fig 15.6. Heat the other end of wire with candle see what happens? Which piece of wax falls down first?

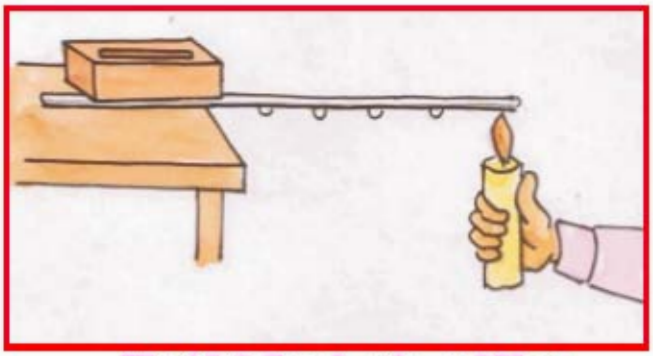


Fig 15.6 Conduction of Heat

By heating one end of the wire, heat is transferred towards the cold end. This method of heat transfer is called **conduction.** The transfer of heat in solid objects occurs by conduction.

Also do this

Wrap the thin paper tape tightly on iron or copper rod. Try to burn it over a candle flame by continuously rotating the rod. You will find that paper does not burn and the other end of rod becomes hot. It is due to the fact that heat given to the paper is absorbed by the rod which moves promptly ahead in rod. Due to this temperature of paper does not rise.

Does heat conduction happen easily in all objects?

Let us learn by doing

Heat conducting and insulating materials

Activity-6

Heat water in a beaker till boiling and dip a plastic scale, pencil, steel spoon, iron nail or wire, aluminium wire as shown in fig 15.7. Wait for some time, than touch the upper end of the objects. The upper end of which of the objects have become hot? Heat flows easily in metals - aluminium, iron, steel, etc. That is why the upper end of all these materials are hot. Now, you may have

Fig 15.7 Difference between Heat conducting & insulating objects

understood why wood, plastic, etc. are less hot?

The materials which allow heat to pass through them easily are called heat **conductors.** In opposition, the materials which do not allow heat to pass through them easily are called **bad Conductors** of heat or heat insulators. For example metals like aluminium, iron and copper, etc., are conductors of heat whereas plastic, wood, ebonite, woollen cloths, etc., are Insulators of heat.

Find out

1. Why are the utensils of cooking food made of metals and their handles made of wood or ebonite?
2. Stainless steel pot usually has a copper base, why?
3. During summers, why is it less troublesome to walk bare foot on a mat or carpet as a covering of heated floor?

Have you ever thought that how woollen clothes protect us from cold in winters? Air is a bad conductor of heat. Air is trapped in tiny pores of woollen clothes. Wool and air being bad conductors of heat do not allow body heat to go out and we are protected from cold. Similarly, during winters, when the body is covered with two blankets simultaneously a large layer of air is formed between the two blankets and gets trapped and we are protected from cold.

If hollow bricks are used during the building construction, then there is less effect of heat or cold on rooms in summer or winter. Why does this happen?

Air and water are bad conductors of heat, then how does heat conduction takes place in these?

Let us learn by doing.

(b) Heat transfer by convection:

Activity 7

Take water in a pot. Place few crystals of potassium permanganate or 4-5 beads of tea leaves in it and heat. Observe water in a port carefully. You may find that water rises above from the centre and lowered from here and there (as in fig 15.8). Colourful currents are set in water. Why does this happen?

When the bottom of the pot is heated the water molecules absorb heat and move upwards whereas the

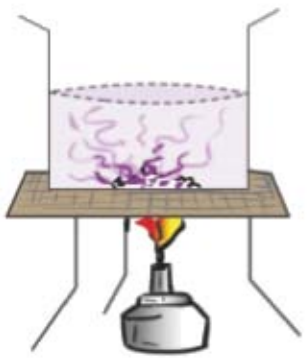


Fig 15.8 Convection of Heat in liquid

upper molecules are cool and move towards the bottom of pot.

By this mechanism, the liquid molecules itself move from one place to another to transfer heat. This method of heat transfer is called **convection** of heat.

Air also convects heat. Air molecules also become lighter after absorption of heat (with low density) and move bottom to the top. The upper cold molecules of air move downward to gain heat.

What are the uses of heat convection in our daily life? Let us discuss about it.

Uses of Convection

1. **Ventilation:** Keeping hand in front of your mouth breath out forcefully. Is the air hot? Generally the air we exhale is hot and of low density compared to normal air. It rises up towards the roof and exits from ventilator near the ceiling and fresh air enters from doors and windows.
2. **Chimney:** Smoke and gases which are come out from houses and factories being hot move upwards and exits through the chimney.
3. **Oceanic currents:** Sun rays fall directly all around the equatorial line as compared to poles. That is why the water in oceans is more hot water near the equatorial circle as compared to poles. This water being remains on the surface and as such flows towards the polar region. The hot water that flows in such a way is called **hot water current.**

   Just opposite of it, the water around the poles is heavy due to its coldness. It flows from poles to equatorial circle. These types of currents are called **cold water currents.**

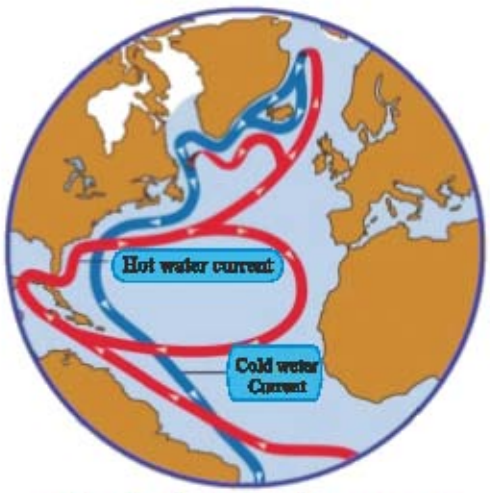
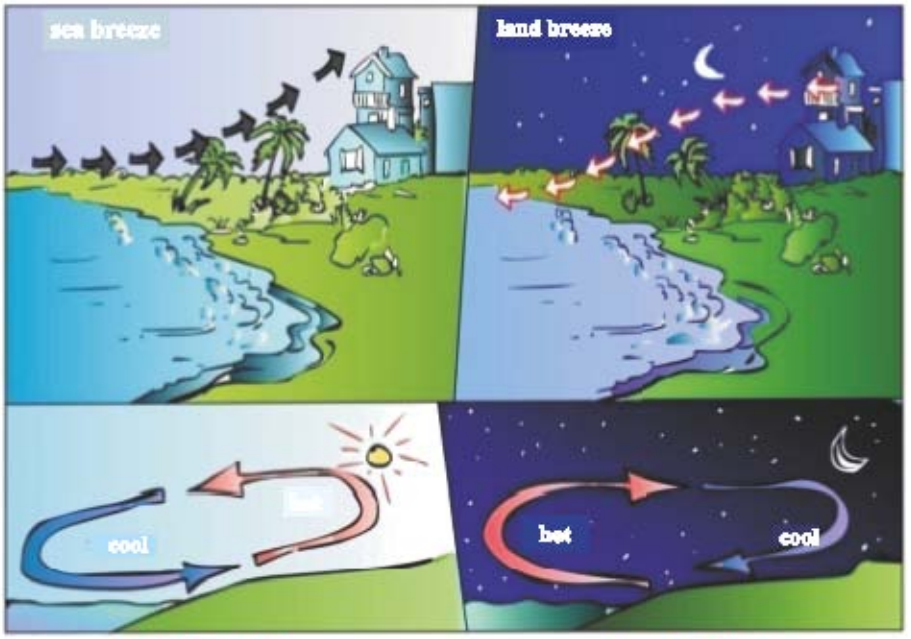


Fig. 15.9 Oceanic current

4. **Air flow:** Air flows from high air pressure to low air pressure area. When a place has high temperature then its air becomes hot, rises up (vertical height) and expands. Because of this air pressure at that place is reduced.

Then, air starts to flow from cool place to hot place.

During the day, the land gets heated up more than the sea water. The cooler air from the sea blows towards the land. It is called **sea breeze.** But at night the land gets cooler fast. The cool air from land blows towards the sea side. This is called the **land breeze.** In summer, during monsoon air flows from the ocean for the same reason and rainfall occurs.



Sea breeze land breeze

Fig.15.10 Air flow

Is it possible to transfer heat without any medium (vacuum)?

(C) Heat transfer by radiation:

There is no medium in the space between earth and sun. We call it vacuum. It is a place where there is no air. This means, that there is total absence of molecules of any substance in vacuum. The heat radiated from sun reaches the earth as light through vacuum. The method in which heat transfer takes place without any medium (in vacuum) is called **Radiation.** There is no requirement of any medium like solid, liquid or gas in the transfer of heat by radiation. Radiation like light is electromagnetic wave which can move with the speed of light in vacuum.

When we sit in front of a heater or stove, we receive heat by radiation. When a hot utensil is moved away from the flame it cools down by transferring its heat to the environment by radiation. In the same way our body also gives up heat to the environment and receives heat from it by radiation.

When heat radiation falls on some object the following activities occur -

1. **Reflection:** Part of incident radiation energy falling on object is reflected back by an object. The lustrous objects are better reflectors e.g. metals.
2. **Absorption:** A part of incident radiation energy falling on object is absorbed by the object. Thus, object becomes hot and its temperature rises. When we go out at noon we feel hot. Due to this reason we use an umbrella or find shade to protect ourselves from the heat. White or light coloured objects absorb less heat as compared to black or dark coloured objects. Now, can you tell why we feel more heat by wearing dark coloured clothes during summers?
3. **Transmission:** When radiation falls on a transparent object then part of it is reflected, part is absorbed and some part is also transmitted.

Also know it

Heat reaches from sun to earth by radiation. Besides the sun, the heat is also radiated by stove, hearth, candle, light bulb etc. Objects with normal temperature like hot tea, living organisms, water, earth and its objects and even ice emit radiations. This type of radiation occurs as waves and is called infrared rays. Most part of this infrared rays emitted from earth goes into space and earth's temperature cools down at night due to this reason.

What have you learnt

- The hotness of an object is called temperature.
- Temperature of an object is measured by a thermometer.
- The laboratory thermometer has a range from -10°C to 110°C whereas clinical thermometer has a range from 35°C to 42°C.
- Normal temperature of human body is 37°C.
- Heat is a form of Energy. Which flows from the object with high temperature towards obejct with low temperature.
- There are three methods of heat transfer: conduction, convection and radiation.
- Normally heat transfer in solids takes place by conduction method. When one end of a solid is heated, then heat transfer occurs towards the cold end. It is called conduction.
- The objects in which heat transfer occurs easily are called conductors of heat

- In convection, the heat transfer takes place through the movement of molecules themselves. The Heat transfer in liquids and gases takes place by convection.
- Radiation is that method of heat transfer which does not require solid, liquid or gaseous medium to transfer heat. It can travel in vacuum also.
- The lustrous objects are better reflectors of heat radiation.
- Black or dark coloured objects are good absorbers of radiation. e.g., due to this reason one should wear light colour in summer and dark coloured in winter.
- Air and woollen clothes are bad conductors of heat. For this reason woollen clothes protect us during winters from cold.

□□□

Exercises

Choose the correct answer

1. Which material is used in laboratory thermometer?
   (A) Sodium (B) Mercury
   (C) Melted aluminium (D) Shining water.
2. In a heat transfer method when molecules themselves move from one place to another to transfer heat, it is called
   (A) Conduction (B) Convection
   (C) Radiation (D) Conduction and radiation both

Fill in the blanks with suitable words

1. Degree of hotness or coldness of an object is called.....
2. A metal spoon is dipped into ice-cream pan for few moments then it will become.....
3. A layer of copper is adhered at bottom of steel pan because copper is good.....of heat.
4. The heat flows from .....temperature object to .....temperature object.
5. Air and water are .....of heat.

In the following statements, tick T against those which are true, and F against those which are false:

1. If we add 1 litre of 35 °C water into 1 litre of 55 °C water then the mixture will have a temperature of less than 30 °C. (T/F)
2. Utensils for cooking food are made up of metals because metals are good conductors of heat. (T/F)
3. The houses, which have outer walls painted with white colour, are less hot in summer days (T/F)

Long answer questions:

1. Explain the difference between heat conductor and insulator with examples.
2. What are the different methods for heat transfer? Explain the difference in each.
3. When we put objects in sun light, why do black objects get more heated up as compared to lustrous objects although having same size and shape?
4. Give the reason for formation of hot currents in sea?
5. Why is the handle of cooking utensils made with ebonite or wood? Give reasons.
6. With the help of a diagram, explain the heat conduction procedure.
7. How are we protected in winter by wearing woollen clothes? State the reason.

Activity based work:

1. Take same sized pots and fill it with same amount of water, oil, sand, salt etc for similar time period in sun. Measure the temperature of each and tell which one becomes rapidly hot and why?
2. Make a chart of thermometers having Fahrenheit and Celsius scales and display it.
3. With the help of a thermometer find out the melting point of ice and boiling point of milk.
4. Measure the temperature of normal water and sugar containing water and compare them.

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