5
TEMPERATURE AND ITS MEASUREMENT

In class VI we learned about different changes that take place in different seasons in the lesson ‘Changes around us’. We wear different clothes in different seasons.

We wear woollen and dark coloured clothes during winter when it is cold out side. Woolen and dark coloured clothes keep us warm. We prefer to wear light coloured cotton clothes when it is hot. They give us a feeling of coolness. You might have wondered why a particular type of cloth is suitable for a particular season.

In winter we feel cold inside the house. If we come out in the sun, we feel warm. In summer we feel hot even inside the house. How do we know whether something is hot or cold? We try to get answers to these questions in this chapter.

Let us do this:  

Some objects are given in the table. Mark these objects as hot or cold?

OBJECT	COLD	HOT
Ice Cream		
Fruit Juice		
Metal Chair Kept in the sun		
Spoon in cup of hot tea		

We see that some objects are cold and some are hot. We also know that some objects are hotter than others while some are colder than others. How do we decide which object is hotter than the other and which object is colder than the other? We need a reliable method to decide the hotness/coldness of an object, Generally hotness or coldness is expressed in terms of temperature. **Temperature is a measure of the degree of hotness or coldness of an object.**

By touching with our hands, we can guess whether a cup of milk is still worth sipping or has become too cold, whether milk is hot enough for making curds etc. But estimating temperature with our hands can, sometimes mislead or confuse us.

Let us do - 1:

Take some coldwater, luke-warm water and hot water in three different vessels. Immerse your left hand finger in the cold water vessel and right hand finger in hot water vessel simultaneously. Wait for two or three minutes. Take off both your fingers and dip them in the luke-warm water vessel.

Fig. 2

What do you feel about hotness of water now? Do both of your fingers feel the same hotness? Though both

fingers are in the same glass of water, one finger we feel it cold and the other feel it hot! Look how our fingers are confused. Hotness and coldness are related to the observer.

Can we exactly decide hotness/coldness of a substance just by touching it? Why? It is not possible to guess the hotness of a substance only on the basis of feel/touch. It is certain that the water in different tubs has different degrees of hotness which cannot be exactly determined simply by touching.

Heat – A form of Energy

Fig. 3

We feel hot when we sit in sunlight or near fire. We feel cold when we put a piece of ice on our palm. Have you ever thought why it is so?

Think it over!

When rice is being cooked you observe the plate on the rice bowl jumps!

Why is it happening?

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Fig. 4

Have you observed water boiling in a vessel with a lid on it? What do you notice?

Have you seen the lid moving up and down and listened to the sound coming out of it? Where does the sound come from? Why is the lid moving? Sometimes the lid might be thrown away too. What is the reason ?

We know that boiled water is being converted to water vapour. The volume of the water vapor increases. The increasing volume of vapour tries to go out. In this process it tries to lift the lid up. What makes the lid lift up? We need energy to lift any object. Where does this energy come from? It comes from the heated water. Where did this water get energy from? From the heat of the fire! Thus heat is a form of energy.

We know that heat is a form of energy that is transferred from an object at higher temperature to one at lower temperature. When we stand in the sun or near fire, heat energy enters our body and we feel hot. When ice is put on our palm, heat energy moves from our body to the piece of ice. That's why we feel cold.

"The energy which makes an object appear hot or cold is called heat."

Let us do - Conversion of Energy.

- Rub your palms together.
  How do you feel?
- Have you ever observed that iron becomes hot when it is beaten with a hammer?
- Take a soapnut seed. Rub it on a stone and touch it. How do you feel?

Fig. 5

In above cases mechanical energy is converted into heat energy.

- Did you ever bath with cold water during winter? What happens?

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- What do you do to protect yourself from cold?

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- How do you get hot water in winter?

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- Generally we heat water to get hot water. How do you heat water? What sources do you use?

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If we use electric heater to heat water electrical energy is converted to heat. Likewise, if we use gas stove, chemical energy is converted to heat. In solar heaters, solar energy is converted to heat.

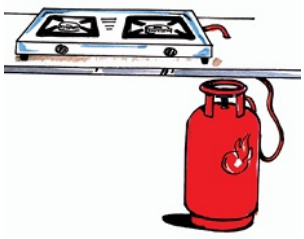


Fig. 6

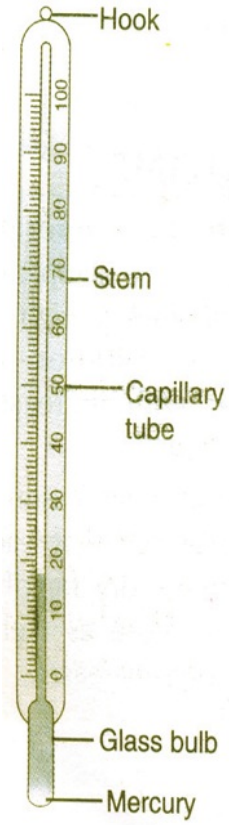
Fig. 7

In the above examples, different kinds of energies are being converted to heat. In the same way heat energy can be converted to other forms of energy. You may have heard that in a thermal power station, heat energy is converted to electrical energy. In a steam engine, heat energy is converted to mechanical energy which helps in moving the engine.

Give examples where heat energy gets converted into other forms of energy and vice versa.

Heat and Temperature:

If you stand close to fire, you feel warm. When a warm object is placed close to a cooler object, heat energy moves from the warmer object to the cooler one until both objects attain the same temperature. Often we think that heat and temperature are the same things; this is wrong. Temperature is a measure of the heat energy in a body and which indicates the ability of a body to give heat to another body or absorb heat from another body. We use thermometers to measure temperature.



Have you observed any thermometers in daily life?

Have you seen the thermometer used by doctor's in hospitals? What does it contain?

How does it help us to measure the temperature?

Let us observe a thermometer:

Hold the thermometer and observe it carefully. What is it made up of?

What do you find inside the thermometer?

What do you find at both ends of the tube?

How do they differ from each other?

At one end of the tube you observe a bulb. It is filled with Mercury. What do you observe at the other end of the tube?

The other end of the tube is sealed after removing air from it. Do you find any markings on the tube? We find a scale which is marked to express temperature in degree Celsius. We read the temperature with the help of these markings. Read the markings on the tube. Where does it start? Where does it end?

This arrangement of the marks is called scale of temperature.

All thermometers are based on the fact that matter expands on heating. To understand the working of a thermometer we need know how matter expands on heating.

Let us do: Expansion of liquid due to heat

Take a flat bottom flask and fill it with coloured water. Fix a cork, having a capillary tube, in the mouth of flask such that level of water is as shown (Fig 9). Place the flask in a metal trough. Pour boiling hot water into the trough and carefully observe the level of coloured water. What do you observe?

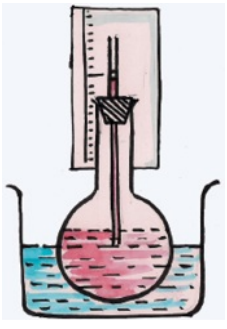


Fig. 9

If you take the flask out of the trough and keep it out side for some time, what do you observe? In

the above activity we see that water expands on heating and contracts on cooling.
So does Mercury. It is used as liquid for indicating temperature in thermometers. Apart from Mercury we also use alcohol as thermometer liquid.

Think:

Why do we use mercury or alcohol as thermometer liquids?

Properties of Mercury:-

- Its expansion is uniform. (For equal amounts of heat it expands by equal lengths.)
- It is opaque and shining.
- It does not stick to the sides of the glass tube.
- It is a good conductor of heat.
- It is easily available in pure state.

Properties of Alcohol

- It can record very low temperatures.
- Its expansion per degree Celsius rise in temperature is very large.

It can be coloured brightly and hence is easily visible.

How to use a thermometer?

To find the temperature of an object, the bulb of the thermometer needs to be in close contact with that object. Watch the shiny line of Mercury in the tube. The highest point on the scale, at which the rise of Mercury stops , shows the temperature of the object.

Example: To find the temperature of your palm, place the bulb of a thermometer in contact with the palm for two minutes and see the Mercury rise. When Mercury stops rising and its level becomes steady, note the position of its upper end. This is the temperature of your palm. How much is it?

If markings on thermometer are wiped out, how do we create new markings?

Take some ice in a beaker. Immerse a thermometer in ice for two minutes. Mark the Mercury level. Now let the ice melt.

Can you observe any change in Mercury level?

The level of Mercury remains same while ice melts. This means that temperature is constant. This constant temperature at which ice melts is called melting point of ice and mark it 0°C.

Take some water in a beaker. Immerse the thermometer in it and start heating the water. It will start boiling while getting converted into steam. Mercury level starts rising and reaches a point beyond which it doesn't rise. Mark the level of mercury at this point. Observe the constant level at which Mercury stays while water is boiling, this constant temperature is called boiling point of water. We mark the level of mercury at this point as 100°C.

Thus temperature at which ice melts or water boils is constant. These values are fixed as 0°C and 100°C respectively. Like water, all substances in pure form melt and boil at certain fixed temperatures.

To create a scale, we need two fixed points let us choose the melting point (0°C) and boiling point (100°C) as two fixed points for the scale of thermometer. Now divide the distance between these two points on the thermometer into 100 equal parts. Think about how we can achieve this.

Eachof the 100 equal parts represents 1°C. We further divide 1°C into 10 small divisions. It can be read as 1/10 = 0.1°C.

Now can you precisely determine which water is cooler and which is hotter than the other in the 3 beaker experiment? If the temperature of the beaker in which we immersed both the hands is 41°C, what can be said about the temperature of water in other beakers?

The beaker containing cooler water will record temperature less than 41°C.

The beaker containing hotter water will record temperature more than 41°C.

Do you know about the first

thermometer?

Fig. 10

First thermometer was invented by Galileo in 1593 AD. In this thermometer air was used as the thermometric substance as air rapidly expands on heating and contracts on cooling. Further, the substance that is used in thermometer has uniform expansion or contraction with the rise or fall in temperature.

Let us do this:

Do you find any difference in temperature of air in shadow and in the sun?

Fig. 11

Fig. 12

Measure temperature of air using a thermometer. What will you do to keep thermometer in close contact with air?

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Record your observations in the following table.

OBSERVATION	RECORDED TEMPERATURE
Air in the shade (at 12 noon)	
Air in the Sun (at 12 noon)	
Morning (at 8 am)	
Night (at 8 pm)	

- What did you observe? Is there any difference in temperature with variation of time or place? .....

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- Why do you use an umbrella in the hot sun during summer?

Fig. 13

Do you know?

In Libya (Africa) on a particular day in the year 1922, it became so hot that the temperature of air even in shade was as high as 58°C. At some places (Rentachintala of Guntur District) in Andhra Pradesh, the maximum temperature of air sometimes reaches 48°C and more. When it is so hot we feel extremely uncomfortable as the normal temperature of the human body is 37°C. The lowest temperature in the world has been measured in Antarctica where it once went down to about -89°C. The minus sign is used for temperature which is less than 0°C. Water freezes at 0°C, just think how cold -89°C must be. In winter when the atmospheric temperature around us becomes 15°C - 20°C we begin to feel cold.

The maximum (highest) and minimum (lowest) temperatures of a day are measured by a thermometer called the Six's maximum - minimum thermometer.

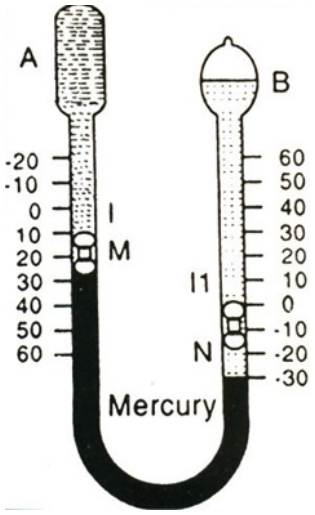


Fig. 14

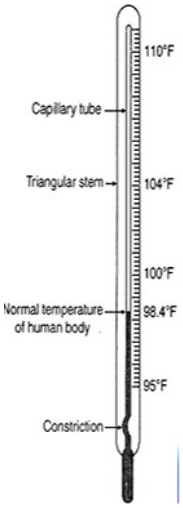
Clinical Thermometer:

Generally when we are suffering from fever our body temperature increases.

Can you find how much the body temperature has increased?

Doctors use a thermometer to find out the temperature of our bodies. It is called Clinical Thermometer.

Hold the Clinical Thermometer in your hand and observe it carefully.



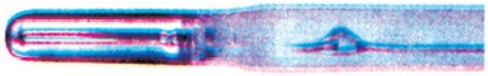


Fig. 15

Fig. 16

There are two types of scales marked on the clinical thermometer one that starts with 35 degrees and ends at 45 degrees is Celsius scale. While the other that starts with 94 degrees and ends at 108 degrees is the Fahrenheit scale.

Do you see a kink in the capillary near the bulb?

This kink prevents Mercury level from falling on its own.

Reading the Fahrenheit Scale on thermometer:

Note the temperature difference indicated between the two bigger marks. Also note down the number of divisions between these marks. Suppose two consecutive bigger marks differ by one degree and there are five divisions between them. Then one small division reads

1/5 = 0.2 ºF

Fig. 17

How to use a clinical thermometer?

Wash the thermometer preferably with an antiseptic solution. Hold it firmly by the end and give it a few jerks. These jerks will bring the level of Mercury down. Ensure that it falls below 35C (95°F). Now place the thermometer under your tongue or arm pit. After one minute, take the thermometer out and note the reading. It tells you your body temperature.

What did you record as your body temperature?

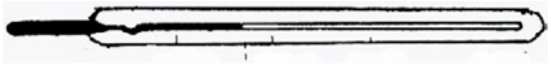


Fig. 18

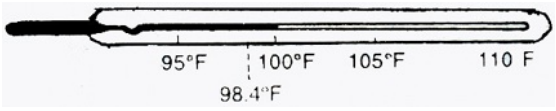


Fig. 19

In the picture first thermometer shows the body temperature of Srikar. Second thermometer shows the temperature of Srinath. Who is suffering from fever? How can you say that?

The normal temperature of human body is 37°C (98.4ºF) which is measured by clinical thermometer.

Let us do this:

Fig. 20

Feel the body temperature of some of your friends by placing your hand on their forehead. Estimate the temperature and record it, in the table.

Measure it now with clinical thermometer. Record your observa-tions in table.

Fig. 21

Make sure that you have cleaned the thermometer before each measurement

Name of the Student	Estimated Temperature by touching	Temperature measured with clinicalthermometer

Compare the values in the table after completion of recording.

- What do you observe in the table?
- Are the estimated temperature and measured temperature same?
- Is the body temperature of every person 37°C (98.4ºF)?
- What is the average body temperature of your friends?

The average body temperature of a large number of healthy persons is known as normal temperature(98.4ºF).

Do you know?

Thermister thermometer:

Fig. 22

It is available in market to measure the human body temperatures, particularly for infants and children.

Can you guess why?

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Digital thermometer:

There is a lot of concern over the use of Mercury in thermometer. Mercury is a toxic substance and is very difficult to dispose of if a thermometer breaks. These days digital thermometers are also available which do not use Mercury.

Fig. 23

Observe with the help of colours

Fig. 24

We are advised not to use a clinical thermometer for measuring the temperature of any object other than human body. Also we are advised to avoid keeping it in the sun or near a flame. Why?

Try this:

Measure the temperature of a person with clinical and digital thermometers. Are the temperature readings same or different? Explain your observations.

How to measure the temperature of other objects?

To measure the temperature of other objects there are other thermometers. One such thermometer is known as the laboratory thermometer.

Laboratory thermometer

Observe the thermometer in Fig 22. It is laboratory thermometer. Label the parts of it. Observe the markings of the laboratory thermometer. What is its range ?

What do you mean by minus degree Celsius?

Is it less than 0°C or greater than it?

How to use it

Take some tap water in a beaker. Dip the thermometer in water so that the bulb is immersed in water but does not touch the bottom or side of the beaker. Hold thermometer vertically, wait till the mercury thread becomes steady. Note the reading. That is the temperature of water at that time.

Fig. 25

Reading the Celsius scale on thermometer

Note the temperature difference indicated between two bigger marks(Fig 23). Also note down the number of divisions between those marks. Suppose two consecutive bigger marks differ by one degree and there are 10 divisions between them then one small division reads

1/10 = 0.1°C

Fig. 26

Let us do this:

Take some hot water in a beaker, dip thermometer in it for one minute. Record the temperature while the thermometer is in water.

Take out the thermometer from water. Observe the mercury thread carefully.

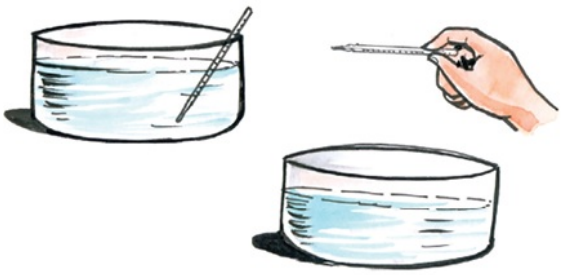

Fig. 27

What do you notice after some time? Why?

We are advised not to use the laboratory thermometer to measure our body temperature. Why?

Hint: (Think about the kink)

How does the laboratory thermometer differ from the clinical thermometer?

Key Words:

Heat energy, Temperature, Thermometer, Fahrenheit scale, Celsius scale, Clinical thermometer, Expansion

What we have learnt?

1. Temperature is the degree of hotness or coldness of an object.
2. Heat is a form of energy
3. Heat flows from an object at high temperature to another at lower temperature.
4. Mercury and alcohol are used as thermometer liquids in thermometer.
5. Doctors use a clinical thermometer to measure the human body temperature.
6. The normal temperature of human body is 37°C (98.4°F)
7. Laboratory thermometer is used to measure the temperature of objects.

Improve your learning

1. The body temperature of Srinath is 99°F. Is he suffering from fever? If so, why?
2. Why do we use Mercury in the thermometer? Can water be used instead of Mercury? What are the problems in using it?
3. Temperature of Srinagar (J & K) is -4°C and in Paderu (AP) is 3°C which of them has greater temperature? What is the difference between the temperatures of these two places?
4. During winter mornings why do people stand in the Sun? Explain.
5. After walking some distance on a hot summer day, why do we prefer to go into the shade?
6. Srikanth takes a sip of cold drink and feels the chill. Guess what its temperature is? Try to measure it.
7. Jyothi was prepared to measure the temperature of hot water with a clinical thermometer. Is it right or wrong. Why?
8. Swathi kept a laboratory thermometer in hot water for some time and took it out to read the temperature. Rani said it was a wrong way of measuring temperature. Do you agree with Rani ? Explain your answer.
9. Why do we jerk a clinical thermometer before we measure body temperature?
10. Heat energy is converted into other forms of energy. Give some examples.
11. Prathima said 'Heat is a form of energy'. How do you support her? Give some examples.
12. Why is a clinical thermometer not used to measure the temperature of air?
13. Fill in the blanks
    a. Doctor uses _____ thermometer to measure the human body temperature.
    b. At room temperature Mercury is in _____ state.
    c. Heat energy transfer from _____ to _____
    d. -7°C temperature is _____ than 0°C temperature.
14. Match the following

i) Clinical thermometer	( )	a) A form of energy
ii) Normal temperature of human body	( )	b) 100°C
iii) Heat	( )	c) 37°C
iv) Boiling point of water	( )	d) 0°C
v) Melting point of water	( )	e) Kink

15. Use the Thermometer and record the temperature in your school daily at mid day meals time in the following table. Record temperature for a month.

Date	Temperature

- On which day was the temperature highest? What could be the reason?

- On which day was the temperature lowest? What could be the reason?
- What was the average temperature during the month?

16. Draw the diagram of a clinical thermometer and label its parts. What is the use of kink in clinical thermometer?
17. Draw the diagram of a laboratory thermometer and label its parts. How does it differ from a clinical thermometer?
18. Measure the body temperature between fingers, under the tongue, armpit,folded hands, folded legs etc., Is it the same? Does the body temperature remain the same after jumping ten times?. Why?
19. Collect information from hospital/health centre about the precautions to be taken while reading temperature with a clinical thermometer.
20. Measure the temperature of water in normal conditions. If you add the following substance to the water, do you find any difference in temperature? Predict and verify.

Water temperature in Celsius	**Prediction**	**Water(100ml each time) mixed with Two tablespoonful of each the substance**	**Temperature of the solution immediately after mixing**
		Glucose	
	Decrease	**Washing powder**	
		Baking soda	
		Sugar	
		Common salt	

Do you find any change in temperature before and immediately after mixing the above substances in water? If yes, what could be the reason?