Heat

Concept of Heat

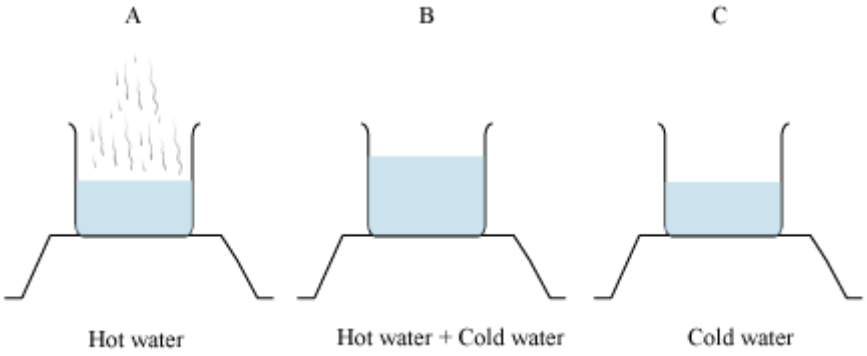
On returning from school, when Ravi touched the iron gate of his house, he found it to be extremely hot. Later, he touched other things made of iron present inside his house and found that they were not hot. Then, he touched other substances (not made of iron) present in his house to determine whether they were hot or cold. He listed the various substances observed in the table given below.

Substance	Hot/ Cold
Tea	Hot
Coffee	Hot
Ice	Cold
Ice cream	Cold
Freshly Cooked rice	Hot
Frozen meat	Cold

Try to make a table listing some other substances, which are present in your house and classify them as hot or cold. **But how do you decide whether a substance is hot or cold? Can you always tell whether a substance is hot or cold simply by touching it?** The following activity will help you understand better.

Activity:

Take three containers and label them as **A, B**, and **C**. Take hot water in container **A**, and cold water in container **C.** In container **B**, mix hot and cold water in equal amounts. Now, place your left hand in container **A** and right hand in container **C** for two minutes. Then, dip both your hands in container **B**.



What can you say about the water present in all three containers? Note your observations in the table given below.

Container	Hot/Cold
A	
B	
C	

What is your observation for container B? Is the water in container B hot or cold?

When you dip your hands in container **B**, your left hand will tell you that the water is cold, while your right hand will tell you that the water is hot. Thus, you will not be able to distinguish whether the water present in container **B** is hot or cold.

From this activity, we can conclude that we cannot decide whether a substance is hot or cold just by touching it. Thus, we need something more reliable than our sense of touch to decide whether a substance is hot or cold.

The measure that can be used to detect the degree of hotness of a substance is called temperature. More the temperature of a substance, the hotter it will be. **The device that is used to measure the temperature is called a thermometer.**

The scales used to measure temperature can either be degree Celsius or degree Fahrenheit. There are two types of thermometers: **clinical thermometers and laboratory thermometers**. The table given below tells us the difference between them.

Types of Thermometers	
Clinical thermometer	**Laboratory thermometer**
This thermometer is used in homes. It is basically used to measure the temperature of humans. A clinical thermometer has a temperature range of only 35ºC to 42°C. **Can you tell the reason why?** This is because our body temperature never goes below 35°C or above 42°C. 	This thermometer is used to measure the temperature of all things, except the human body. A laboratory thermometer has a temperature range of -10ºC to 110ºC (Nowadays, laboratory thermometers have range till 300ºC). 

Why can we not use a laboratory thermometer to measure the body temperature of humans? Let us perform a small activity to understand.

Activity:

Take a beaker full of water. Now, dip a laboratory thermometer in it. Make sure that it touches neither the bottom of the beaker, nor the walls of the beaker. You will see that the mercury line rises for some time, but then ceases to rise. Note the reading where the mercury stagnates. This is the temperature of water. Take out the thermometer.

What do you observe? The mercury starts falling rapidly. This means that with a laboratory thermometer, temperature has to be read when placed in water. On the other hand, to measure the body temperature, the thermometer has to be taken out of the mouth to note the reading. Thus, it is not convenient to use a laboratory thermometer.

The mercury level does not fall in clinical thermometer even after taking it out of our mouth because it has a provision called kink. It prevents the mercury level from falling on its own.

Do You Know:

Mercury is a very toxic substance. Hence, now-a-days digital thermometers have become more popular, which do not contain mercury.

Conduction and Classification of Objects as Conductors and Insulators

You must have observed that each part of a frying pan becomes hot when kept on a flame. Again, when the hot pan is removed from the flame, it cools down. **Do you know why this happens?**

This is because in the first case, the transfer of heat takes place from that part of the pan which is directly in contact with the flame to the other parts. In the second case, transfer of heat takes place from the pan to its surroundings. Thus, in both cases, **heat flows from a hotter region to a cooler region. This process of heat transfer is called conduction.**

Conduction is a process in which heat is transferred from the hotter end of an object to its cooler end.

Lets understand the process of conduction with the help of the following animation.

In solids, heat is generally transferred by the process of **conduction.** Various solid substances can be classified into two types, based on whether they can conduct heat or not. Some materials allow heat to pass through them, while others do not. On this basis, materials are classified as **conductors** or **insulators**.

Conductors

The substances that allow heat to pass through them are called **conductors** of heat. Iron, copper, and aluminium are examples of conductors. All metals are good conductors of heat.

Insulators:

The substances that do not allow heat to pass through them are called **poor conductors** of heat or **insulators**. Plastic and wood are examples of insulators.

Have you ever observed a cooking utensil carefully? Cooking utensils such as pressure cookers are made of metals and their handles are made of either wood or hard plastic. **Can you explain why?**

As metals are good conductors of heat, they are used for making cooking utensils. However, the handles of the utensils are made of either wood or hard plastic because they are bad conductors of heat. Therefore, when the vessel gets heated, the handle remains at room temperature. Thus, it is easier to lift the utensil with the help of the handle, without getting burnt.

Transfer of Heat Through Convection

We know that heat flows from a body of higher temperature to a body of lower temperature. **However, can you tell how heat is transferred from one body to another, or within the same body? Or, how does heat get transferred when there is no medium between the bodies transferring heat?**

There are three ways by which heat can flow from one object to another. They are: **conduction, convection,** and **radiation**. In this part, we will learn how transfer of heat takes place through convection.

Convection

The process of transference of heat through a fluid (liquid or gas) is called **convection**. Water and air are poor conductors of heat, and heat transfer in these mediums takes place by the process of convection.

The concept of convection can be understood with the help of the following activity.

Activity 1:

Take a flask and fill it with water. Place it on a tripod stand (as shown in **figure 1)**. Now, using a straw, gently place a crystal of potassium permanganate in the centre of the flask. Place a burner below the crystal and heat the water.

Figure 1: Transfer of heat by convection in water

It can be observed that when water is heated, water near the flame gets hot and starts rising up. On the other hand, cold water moves down from the sides of the flask, towards the source of heat. Then, this water becomes hot and rises up. This process continues till all the water present in the flask gets heated. This process of heat transfer is called **convection**.

Similarly, when air is heated, the air present near the heat source gets heated and rises up. On the other hand, the air from the sides come towards the source, gets heated, and rises up. In this manner, air gets heated by the process of convection.

Do you know why winds blow near the coastal areas? Two types of winds are experienced near the coastal areas− **sea breeze and land breeze**.

Sea breeze

Sea breeze is the wind that blows from the sea towards the land. It develops during day time.

Lets understand the formation of sea breeze with the help of a animation.

Do you know that it is for this reason that the windows of houses in the coastal regions are built in such a way that they face towards the sea to receive the cool sea breeze.

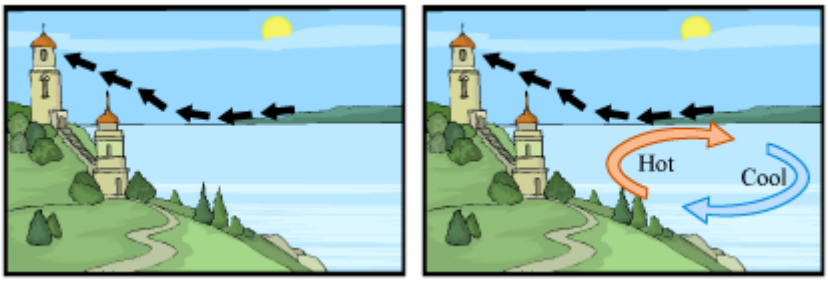


Figure 2: Sea Breeze

What is land breeze?

Land breeze is the wind that blows from the land towards the sea or the oceans. It develops during night time.

Land cools down faster than water. Therefore, during night time, land is cooler than sea. Hence, cool air from the land blows towards the sea. This is called the **land breeze (**see **figure 3).**

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Heat Transfer Through Radiation

You know that heat flows from a body of higher temperature to a body of lower temperature. **But, do you know how the transference of heat takes place? How**

does heat travel through various media? And, how is it transferred in the absence of a medium?

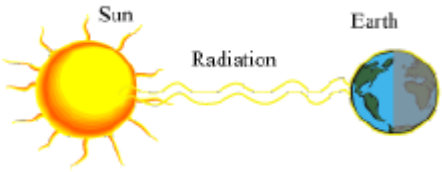
Transfer of heat can take place by three ways: **conduction, convection,** and **radiation.** In solids, the transfer of heat takes place by conduction. In liquids and gases, heat transfer takes place through convection. When no medium is present, heat transfer takes place by radiation.

Here, we will study about the transfer of heat through radiation.

Radiation:

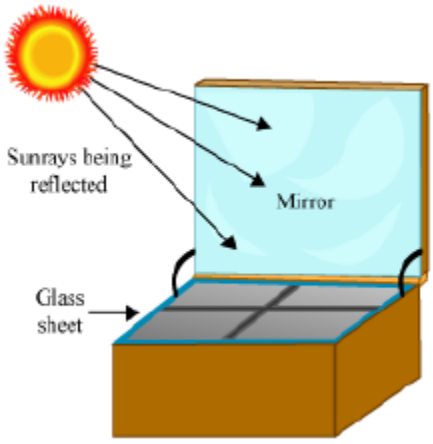
Radiation is a method of heat transfer which does not require a medium.

For example, the Earth receives heat energy from the Sun by the process of radiation. We know that most of the space present between the Earth and the Sun is nothing but vacuum. Hence, there is no medium existing between these two heavenly bodies. Therefore, the heat that the Earth receives from the Sun is a result of the transference of heat through radiation.



Transfer of heat from the sun to the Earth by the process of radiation

A solar cooker also functions because of the heat energy obtained from the Sun by the process of radiation.



Solar cooker obtains heat by the process of radiation

When we sit in front of a room heater, we feel hot. The heat that we obtain from the room heater is through radiation.

All hot bodies radiate heat. Our body also radiates heat to our surroundings. When heat falls on an object, a part of it gets reflected, another part is absorbed, and yet another may get transmitted. The temperature of an object increases because of the heat energy that is absorbed.

Do You Know:

It is advised to use dark coloured umbrella while going out in the Sun. This is because dark coloured umbrella, black being the best, absorbs most of the light and radiations coming from the Sun and gets heated. Then it radiates this heat back into the atmosphere. Hence, in this way we are protected from the heat of the Sun.

Effects of Conduction and Radiation on the Clothes We Wear

We know that heat flows from hot objects to cold objects and heat transfer can take place by three processes, i.e., conduction, convection, and radiation. We also know that the temperature of an object increases when it absorbs heat energy. **Now, does the absorption of heat by a particular object depend on some factors or do all objects absorb heat at a constant rate?** Let us perform a simple experiment to understand better.

The heat absorbed by an object depends on various factors. One such factor is the **colour** of an object. In the above experiment, it will be observed that the temperature of the black-coloured metal container increases at a rate, which is more than the rate at which the temperature of the white-coloured metal container increases. This is because black colour absorbs all the radiation that is incident on it. On the other hand, white colour does not absorb radiation at all. Rather, it reflects radiation.

This is the reason why white or light-coloured clothes are preferred in summers, and black or darker shades are preferred in winters.

Not only does black colour absorb heat quickly, it also loses heat at a slow rate. Thus, black clothes retain heat for a longer duration. This can be demonstrated by performing a simple experiment.

Apart from the colour of an object, what other factors affect the heat absorption or reflection ability of an object?

We know that solids can be classified as good conductors (conductors) or bad conductors (insulators) of heat. Substances that allow heat to pass through them are called **conductors**, while those that do not allow heat to pass through them are called **insulators**. **Can you tell why woollen clothes are preferred in winters?**

There are many gaps present in wool, which traps the air inside. As air is a poor conductor of heat, wool does not allow the transfer of body heat to the environment. Hence, heat loss is very less through woollen clothes. Thus, woollen clothes are preferred in winters. On the other hand, in cotton fibres, large holes are present through which air can pass. This is why cotton remains cool in summers. Therefore, cotton clothes are preferred in summers.