CLASS-VIII

8

MECHANICAL ENERGY AND HEAT

You must have experienced that we get tired of working continuously for too long and say that there is no strength to work anymore.

What do we mean by the word 'Strength' here? In the previous lesson you read that the ability of a body to function is a measure of the energy of that body. So we are using the word strength for energy only. By working, our energy decreases and we have to take diet to get it back.

Energy in objects is due to various reasons, as a result of which we recognize energy in different forms. We will study some basic forms of energy in this chapter.

OBJECTIVES

After reading this lesson you will be able to:

- understand mechanical energy;
- Having to know heat and temperature; and
- able to indicate the importance of heat in our life.

8.1 MECHANICAL ENERGY

You must have seen that the water of the river descending from the mountain carries large stones with it. A lot of energy is required to move the stone. Have you thought about what energy is in the flowing water? You must have also noticed that in the plains, where the velocity of water decreases, stones do not move as easily. That is, this energy in water is associated with its speed. The energy which is due to its motion in a moving object is called 'kinetic energy'. When the moving cricket ball hits the stumps, they crumble and fall. In the game of carrom when the striker collides with a stationary object, then that object moves forward. In both of these examples kinetic energy only works.

We can see that if you put a moving small toy car on the table and when it collides with a box of matches, the box of the match box moves away. If the mass or velocity of the toy car is increased, the matchbox moves more far. Meaning: The kinetic energy of an object depends on the mass and velocity of that object.

The ability of the object to function also comes due to its position, which we call potential energy, such as pulling the rubber strips into the slingshot brings them potential energy, due to which when we release the strips The stone placed in the center falls away. When you key in the clock, the potential energy comes due to cramps in the watch. When this spasm opens, the clock needle starts to move, by lifting the hammer it gains potential energy, due to which when the hammer hits the peg then the peg penetrates into the ground.

You may have also noticed that when the weight of the hammer is high or if it falls from a high height, the peg goes deeper into the ground in each injury, that is the gravitational potential energy of an object depends on the weight and height from the floor.

Due to the motion or position of the object, the energy it contains is directly converted into work, hence it is called mechanical energy. Thus there are two types of mechanical energy, kinetic energy and potential energy. When an object falls from the top or rolls down on the bottom, its potential energy decreases and in the same result the kinetic energy increases. Thus the total mechanical energy of that object remains constant. For example, a rock placed on the top of a mountain has no kinetic energy, only potential energy, so its total mechanical energy is only potential energy. However, when the same rock starts rolling, it has both potential and kinetic energies at some point on the hillside. When the rock goes under the mountain, there is no potential energy in it and the total mechanical energy is kinetic energy. Thus we see that in any case the total mechanical energy of the object is the potential energy () kinetic energy.

To understand the concepts mentioned above more clearly, let's do an activity:

ACTIVITY 8.1

What you need to do: Study the mechanical energy of a body.

What you need: A long nail, thread, metal ball with a hook, a dense piece of wood.

How to do you:

1. Hammer the nail into the wall at a height of about 1 meter from the floor.
2. Tie the metal sphere to the thread and hang it on the nail in such a way that it stays slightly above the floor.
3. Keep a wooden block close to the sphere.
4. Hold the sphere and slightly move it to a certain position and then leave it free. See what happens?
5. Place the Wooden block in the first place and remove the sphere by removing it a little bit further. See what happens?

What you have seen is that the farther away we leave the sphere, the higher the velocity it hits with the wooden block and the faster the sphere hits the block, the more the block moves further.

From this we can conclude that:

1. Moving spheres have kinetic energy. Due to which it performs the task of repelling the block.
2. The farther you move the sphere, the higher it rises from the original position. As a result, the more potential energy comes into it.
3. As the sphere moves from the position of maximum displacement to its original position, its potential energy is converted into kinetic energy and the velocity increases. In the case of maximum displacement, the total mechanical-energy is equal to the potential-energy, whereas, in the original state it is only in kinetic energy.

INTEXT QUESTIONS 8.1

Fill in the blanks:

1. The energy due to its motion in an object is called …….
2. Mechanical energy is the sum of.....energy and..... energy.
3. There is no change in the …….. energy of a glass ball rolling on the horizontal plane.
4. Stagnant water filled in the dam has …… energy.
5. If you double the height of the object from the floor, its potential energy gets ……...

8.2 HEAT AND TEMPERATURE

Winter, summer are common experiences of our life. The form of energy that gives us the feeling of cold, hot is called heat. If heat goes outside our body, we feel cold and if heat enters our body from outside the environment then we feel hot.

This physical amount which determines the direction of flow of heat is called temperature. Heat always flows from high temperature to low temperature. You will remember that during the summer days when the temperature of the air exceeds our body temperature (about 37 ° C) then we feel hot and on winter days when the temperature of the room falls below 37 ° C. we feel cold.

Heat is a form of energy, it is not difficult to understand. You must have noticed that when a plate is covered on a boiling water vessel, the plate rises again and again under the pressure of steam. Obviously, the work that steam does in raising the lid is possible

only due to heat. By the energy of steam from the steam engine, a piston is driven back and forth, and it is converted to work as needed. So heat, because it can work, is a form of energy.

Around us we can see other types of energy changing to heat, such as the chemical energy in the burning of a candle converts into heat, the electric energy in an electric furnace turns into heat, the mechanical energy in working against friction is heat.

In fact, basically heat and temperature are associated with the kinetic energy of the molecules of matter. The higher the average kinetic energy of the molecules of a substance, the higher its temperature and the kinetic energy of its molecules increases when the substance is heated.

Effects of heat

One or more of the following effects are manifested in an object upon heating: (i) increase in size, (ii) increase in temperature, (iii) change in state, (iv) change in certain physical and chemical properties, (v)) Decay of living cells etc.

Let's study some of these effects by activities:

(i) Thermodynamic

ACTIVITY 8.2

What you need to do: See if the length of a rod increases with heating.

What you need: Two identical wooden blocks, a metal rod with a hole made at one end, a round pencil, spirit lamp, screw and screwdriver.

How to do you:

1. Place the rod on the block.
2. Put a screw in the hole present at the end of the metal rod and tighten it in a wooden block.
3. Place the pencil under the other end and put the indicator on one end of the pencil.
4. When the rod is heated in the middle with a spirit lamp. What changes are seen in the indicator and pencil position?
5. Remove the spirit lamp and allow the rod to cool.

What you noticed: On heating the rod, the pencil is rolled slightly forward and the indicator rotates slightly compared to its first position. On cooling, these two almost return to their former positions. From this we can conclude that solids expand when heated and shrink when cooled.

You should know that liquids also expand when heated like solids. To understand this, let's try an experiment.

ACTIVITY 8.3

What you need to do: See if the fluids also expand when heated.

What you need: a test tube holder, a cork with a hole and a large candle, colored water, glass tube.

How to do it:

1. Fill the test tube with colored water up to the mouth.
2. Put a glass tube in the hole of the cork and place it well in the test tube, so that the water does not flow out of the mouth of the test tube. The water will climb into the glass tube to some height.
3. Hold the test tube with the holder and heat it on top of the burning spirit lamp. See the bottom of the water in the glass tube.

What you saw: The floor of the water gets high in the hot glass tube. From this we can conclude that on heating the fluid expands and this diffusion in liquids is much higher than that of solids

Comments: By taking kerosene in place of water and heating it for equal time, it can be seen that on equal heating, heat diffusion in different substances varies.

The use of heat diffusion

On heating the material they expand. There are many uses of this fact in our lives. Thermodynamics are often used in thermometers. The higher the temperature, the higher the spread. Hence heat can be compared by diffusion. The blacksmith first heats the rim to mount an iron rim to the wooden wheels of the cart, which increases its diameter and easily mounts to the wheel. When cooled, this rim shrinks and sits tightly on the wheel. Curves are made in between to facilitate the flow of hot water in pipes. Similarly, when making railway tracks rails, spaces are provided between two joints.

ACTIVITY 8.4

What you have to do: See if the gas also expands on heating?

What you need: test tube, one hole cork, hollow glass tube, test tube holder, candle

How to do:

1. Put a glass tube in the cork hole and place it in the test tube.
2. Put a drop of colored water in a hollow glass tube.
3. Gently heat the test tube over a candle flame. Observe the change in height of the drop of colored water in the tube.
4. Allow the test tube to cool. Now what changes in the height of colored water drop?

You saw: that on heating the test tube, a drop of colored water rises in the glass tube and on cooling it returns back down. From this we can conclude that the volume of gas increases on heating and decreases on cooling.

Notes:

1. It has been observed by experiments that all the gases have the same thermal diffusion, that is, they are increased uniformly by equal heating.
2. Thermal diffusion is much higher in gases than in liquids.

INTEXT QUESTIONS 8.2

1. What do we do to remove the glass stopper in a lab bottle? Why?
2. Is there an equal thermal diffusion in all solids when heated evenly?
3. Why is it difficult to show thermal expansion in solids?
4. State one of the uses of thermal expansion.
5. When compared between liquid and gas, which one has more thermal diffusion?

8.3 HEAT AND TEMPERATURE

The measurement of the heat or coldness of an object is called the temperature of that object. Often, the object is thought to be hot or cold by touching it. But be aware that the temperature of objects cannot be accurately estimated by touching. Let us try an experiment for this.

ACTIVITY 8.5

What you have to do: See that the temperature of objects cannot be accurately estimated by touching.

What you need: Three plastic tubs, a little cold water, a little hot water and a little tap water.

How to do:

1. Put on the table the three tubs alongside.
2. In tub (A) put cold water, hot water in the second tub (B) and tap water in the third tub (C).

3 Keep your left hand in cold water and your right hand in hot water for some time.

4. Now keep both hands together in normal water. Do both hands feel the same temperature?

What you saw: The left hand feels hot and the right hand feels cold. Although the temperature of the entire water in the tub is the same, it appears to be different due to the difference in the initial temperature of the two hands. Therefore, the temperature of an object cannot be accurately estimated by touch.

Fig. 8.5 Estimating temperature by touching

Thermometer

The instrument, which is used to measure the temperature of an object, is called a thermometer. We measure temperature in degrees Celsius or degrees Fahrenheit.

We use different types of thermometers for different purposes. Figure 8.6 shows two different types of thermometers. The thermometer shown in Figure (a) is a laboratory thermometer, it

has signs from zero to 100 ° C () and is used to measure the temperature of objects in the laboratory.

Figure (b) shows a medical thermometer. We use it to measure fever. It has signs from 30 ° C to 42 ° C (or 95 ° F to 110 ° F). In this thermometer, there is a small bend in the tube just above the bulb, due to which the mercury rises up after getting heat but does not automatically return. You must have seen that before using a medical thermometer, first wash it, then jerk it to lower the mercury, after that apply it to the body.

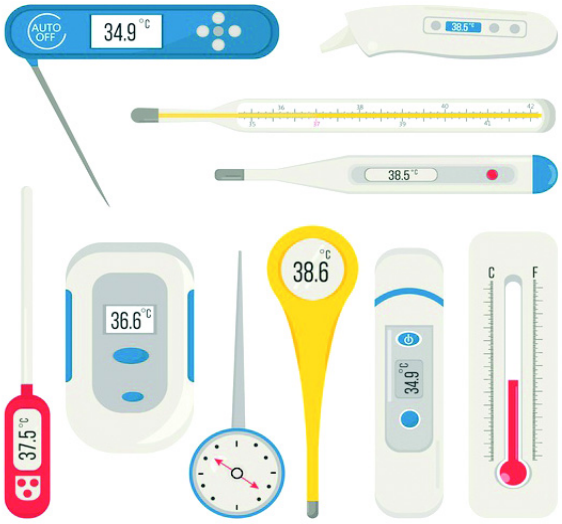

Fig. 8.6 Different types of thermometer

Similarly, the maximum-minimum thermometer is also a type of thermometer. It is used by meteorologists to know maximum how much atmospheric temperature is reached in 24 hours time and how much less?

An oven thermometer or a metal thermometer is generally used to measure extreme temperatures. To learn how to use a medical thermometer, let's do the following activities.

ACTIVITY 8.6

What you need to do: Study the medical thermometer and find the temperature of your body by it.

What you need: A medical thermometer.

How to do:

1. Observe the scale of a medical thermometer and find the temperature to be determined by a small fraction of it.
2. Hold the thermometer tightly and give 2-3 shocks so that the thin line of mercury goes below 35 ° C inside the thermometer.
3. Now place the thermometer bulb under your tongue for about 1 1/2 minutes.
4. Take out the thermometer from the mouth and see what mark the upper end of the bright line of mercury is?

What you saw: Generally, the upper end of the mercury line is at 37 ° C. This is the temperature of your body.

INTEXT QUESTIONS 8.3

1. In which heat premises can a medical thermometer measure heat?
2. What type of thermometer would you use to measure the heat of the stove?
3. Which fluid is filled in a medical thermometer?
4. Why the mercury does not come down in the medical thermometer when taken out of the mouth?

8.4 HEAT MEASUREMENT

So you know that if a substance is heated, its temperature usually increases. The heat rise in a substance for a certain amount of heat depends on the mass of the substance and its nature. This can be easily understood by the activity given below.

ACTIVITY 8.7

What you have to do: To study the temperature rise in substances when given equal heat.

What you need: a small vessel for heating the fluid, laboratory thermometer, 400ml water, 200ml vegetable oil, a heat measuring pot of 200g, spirit lamp.

How to do you:

1. Put 200ml water in the vessel and find the temperature on it with a thermometer.
2. Heat the vessel slowly with a spirit lamp and note its temperature. Stir the water continuously with a spoon.
3. After five minutes, measure its temperature and find the temperature rise.
4. Repeat the experiment separately with 400ml water and 200g vegetable oil.

What you noticed: (i) There is more temperature rise when more heat is given. (ii) The heat increase was halved when the same amount of heat was given to double mass of water (iii) The heat increase was higher due to the same heat in 200ml vegetable oil as compared to 200ml water. From this we come

to the conclusion that the increase in heat of a substance upon giving equal heat depends on its mass and nature.

Heat unit

The unit of heat is calorie. A calorie is the amount of heat that increases the temperature of 1g of water by 1 ° C.

Energy derived from food is measured in a large unit of kilo calories.

1 kilocalorie = 1000 calories.

Because heat is a form of energy, therefore its common unit is joule

1 calorie = 4.18 joule

Phase change

You know that every substance is solid, liquid or gas found in three states. When heating a solid, at a particular temperature it starts to turn into a liquid and it remains constant until the whole solid melts. This particular temperature is called the melting point of the solid.

Similarly, when the fluid is heated, it will begin to change into a gaseous state by boiling at a particular temperature and will remain constant until the entire fluid becomes a gas by boiling. This temperature is called the boiling point of the fluid. Let us study the process of phase change by heating ice.

ACTIVITY 8.8

What you need to do: Study the phase change in water.

What you need: A beaker, a few pieces of ice, wire mesh, tripod-stand, spirit-lamp, laboratory thermometer, iron stand.

How to do you:

1. Place a wire mesh on the tripod stand and light the spirit lamp under it.
2. Put ice pieces in the beaker and place it on top of the mesh and adjust the thermometer vertically in the ice.
3. After a while, note the temperature in the thermometer and note the change in the beaker.

What you saw: (a) The ice starts melting at 0 ° C and the temperature remains at 0 ° C until the entire ice is melted. (B) After the whole ice turns into water, its temperature starts increasing and increases to 100 ° C. (C) At 100 ° C, water starts boiling and converts into steam and this temperature remains constant.

Based on these observations, we come to the conclusion that the melting point of ice is 0 ° C and the boiling point of water is 100 ° C.

INTEXT QUESTIONS 8.4

Fill in the blanks:

1. The amount of heat that increases the temperature of 1g of water by 1 ° C is called .....
2. One kilocalorie = ……. Calories
3. The melting point of ice is = ... ° C.
4. The boiling point of water is = ... ° C.

8.5 TRANSFER OF HEAT

Have you ever thought that, why the top end of the spoon gets hot soon after putting it in a teacup? Leave the hot object for a while, so why does it become cold? Or how does the heat from the sun reach the earth?

You must have understood that heat actually transfers from high temperature to low temperature. This transfer of heat occurs in three different ways. They are (i) conduction (ii) convection, and (iii) radiation. Let us study various methods of heat transfer through some activities.

Thermal Conduction

ACTIVITY 8.9

What You Have to Do: Study of Thermal Conduction.

What you need: An iron bar, stand, small iron nails, a big candle.

How to do:

1. Place the iron bar in the stand so that it is horizontal.
2. With the help of wax, stick nails at approximately equal distances from its lower end.
3. With the help of a candle, heat the free end of the bar. See what happens

You will see that the nail near the hot tip first falls down and then the subsequent ones fall. The nail near the clasp falls at the end.

It is evident that from the hot part of the rod, slowly the heat moves towards cold and in this process the particles of the rod are affected respectively. As a result, the wax near the candle first melts and then wax near the clasp melts in the end.

Thermal: If the transfer of energy is such that the particles in the hot part give energy to the particles near them, then they pass to the particles near them and thus the energy reaches the cold part, then this mode of energy transfer is called thermal conduction. .

ACTIVITY 8.10

What you have to do: See that not all substances are the same conductors of heat.

What you need: One aluminum and one metal rod of similar thickness, two stands, candles, small iron nails.

How to do:

1. Tighten aluminum in one stand and iron rod in the other stand.
2. Place both of them in front of each other in such a way that the free ends are almost touching.
3. On both rods, stick iron nails with wax at an equal distance from the free ends.
4. Warm the free ends together with the help of a candle and see from which rod the spikes fall first.

Did you notice that the spikes fall from both rods, but spikes fall from aluminum rods first. That is, we can say that aluminum is a better conductor of heat than iron.

The transfer of heat to all solids is by conduction method.

In fact all metals like gold, silver, copper, brass, etc. are good conductors of heat, but their conductivity varies. Most non-metals, such as wood, plastics, textiles, leather, asbestos, etc., are not good conductors of heat, that is, bad conductors.

We use both bad conductors and good conductors in our lives. Our cooking utensils are conductors of heat, but the handles in them are made of bad conductors material. If you think, you will be able to find many such examples around you.

INTEXT QUESTIONS 8.5

1. What is the necessary condition for the transfer of heat from one object to another?
2. Why does the iron handle is made of ebonite?
3. Were houses made of gold in gold lanka would have been comfortable?
4. When the thermometer is placed in contact with a hot object, why does the mercury climb up and stop?

Heat Convection

The transfer of heat into liquids and gases is mainly by convection. Let the following activities to understand convection process:

ACTIVITY 8.11

What you need to do: Study of heat convection in water.

What you need: A beaker, tripod stand, wire mesh, spirit lamp, some crystals of potassium permanganate.

How to do you:

1. Fill the beaker with about half of the water and place it on top of a tripod stand with a wire mesh.
2. Pour 4-5 crystals of potassium permanganate slowly into the beaker of water.
3. Heat the beaker with a spirit lamp and watch the movement of colored water rising from the crystals in the beaker.

What You Seen: The colored water rises above the bottom of the beaker and turns from the surface of the water and returns to the bottom. Do you know why this happens? In fact, water gets warmer and becomes lighter, hence it rises and colder water comes down to replace it. In this way a circle is formed in the water, which keeps going until all the water comes to a temperature.

This process of transmission of heat, in which the hot liquid moves itself by transferring heat towards the cold part, is called convection.

INTEXT QUESTIONS 8.6

1. Would it be appropriate to install electric heat near the ceiling or near the floor? Why?

2. In which state of matter is there no heat convection? Why?
3. Is the transfer of heat in water by conduction or by convection?

Thermal Radiation

Radiation is a method of transferring heat that does not require any medium. The invisible rays of heat from the hot object spread in all directions and if it falls on any other relatively cold material, it makes it hot. Heat from the Sun reaches the Earth by radiation. Most of the distance between the Sun and Earth is vacuum, so the transfer of heat by radiation can also occur in vacuum.

If the distance of the object from the source of heat is increased, then the amount of heat reaching it by radiation is reduced. This is the reason that the further away the planet is from the Sun, the lower the average temperature of its surface.

An important fact in relation to thermal radiation is that the magnitude of thermal radiation absorbed by an object depends on the color of that object. Let us ensure this fact by an activity.

ACTIVITY 8.12

What you need to do: To study the effect of surface colors on the absorption of thermal radiation.

What you need: 4 tin boxes with the same volume and shape, black, white, blue, yellow paint, brush, thermometer.

How to do you:

1. Paint the outer surface of the first box with yellow, second with blue, third with white, and the fourth one with black.

2. Put the same amount of water in the four boxes and keep them in the sun for one hour.
3. Find the temperature of water in four boxes one by one.

What you noticed: That the lowest temperature rise occurred in the white box and the highest in the black box.

Conclusion: We can say that the black surface has the highest absorption of thermal radiation and the white surface the least.

Similarly, it can also be seen that black color is the best emitter of heat and white color is the lowest.

INTEXT QUESTIONS 8.7

1. Why do we wear light colored clothes in summer and dark colors in winter?
2. Between Mercury and Mars which of the planets have lower average surface temperature? Why?

WHAT HAVE YOU LEARNT

- A moving object has kinetic energy.
- The ability of an object to function due to its position is called potential energy.
- The mechanical energy of an object is the sum of its kinetic and potential energy.
- Heat is a form of energy.
- The substance expands on heating and shrinks upon cooling.

- Thermal diffusion is lowest in solids and highest in gases.
- Thermal propagation of liquids is used to measure heat with a thermometer.
- To increase the temperature of 1g of water to 1 ° C, 1 calorie of heat is required.
- The standard unit of heat is joules. 1 calorie = 4.18 joules.
- At the melting point, the solid is converted into liquid and at boiling point the liquid is converted into gas.
- Heat flows from the hot object to the cold object until the temperature of both is equal.
- Three methods of heat transfer are conduction, convection, and radiation.
- Darker objects are better absorbent and better emitters of thermal radiation than light colored objects.

TERMINAL QUESTIONS

1. Write five examples of kinetic energy.
2. Write five examples of potential energy.
3. Explain by an example that mechanical energy is the sum of potential energy and kinetic energy.
4. Write two effects of heat.
5. Use of liquids and gases to measure temperature is practical, why?

6. How will it be proved that different masses of a substance when heated the same amount increases in temperature depends on their mass.
7. To distinguish between temperature and heat.
8. What is the difference between conduction and convection?
9. Why do we not feel cold when wearing woolen clothes?
10. Describe an experiment that showed that the radiation of heat by an object depends on the color of its surface.
11. Why are there storms? Explain

ANSWERS TO INTEXT QUESTIONS

8.1

1. kinetic energy
2. kinetic energy potential energy
3. Mechanical
4. Potential
5. Two

8.2

1. Keep the bottle in warm water from the side of the mouth, because doing so will spread the mouth.
2. No
3. Because the heat diffusion in solids is very low.

4. In making thermometers, To mount an iron rim on the wooden wheels of a horse cart.
5. Gas

8.3

1. 30 ° C to 42 ° C
2. Laboratory thermometer
3. Mercury
4. Because in the medical thermometer, there is a small bend in the tube just above the bulb.

8.4

1. 1 calorie
2. 1000 calories
3. 0 ° C
4. 100 ° C

8.5

1. There should be a temperature difference between both the objects.
2. Because avonite is a bad conductor of heat.
3. No, because Sri Lanka is near the equator there is a lot of heat. And because gold is a very good conductor of heat, it would be very hot inside the houses.

4. Because a small bend in the tube near the bulb of the thermometer, is there due to which the mercury does not fall down on its own.

8.6

1. Near the floor
2. In solid state
3. By convection

8.7

1. Because light colored clothing absorbs less of thermal radiation, it protects us from heat during summer, while dark colored clothing protects against heat radiation. They absorb the most, hence give us more heat during winter.
2. Mars because Mars is at a greater distance than Mercury from the Sun, due to which thermal radiation reaches there less.