Physics

Standard

IX

Part - 2

Government of Kerala
Department of General Education

Prepared by
State Council of Educational Research and Training (SCERT) Kerala
2024

THE NATIONAL ANTHEM

Jana-gana-mana adhinayaka, jaya he
Bharatha-bhagya-vidhata
Punjab-Sindh-Gujarat-Maratha
Dravida-Utkala-Banga
Vindhya-Himachala-Yamuna-Ganga
Uchchala-Jaladhi-taranga
Tava subha name jage,
Tava subha asisa mage,
Gahe tava jaya gatha.
Jana-gana-mangala-dayaka jaya he
Bharatha-bhagya-vidhata
Jaya he, jaya he, jaya he,
Jaya jaya jaya, jaya he

PLEDGE

India is my country. All Indians are my brothers and sisters. I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give respect to my parents, teachers, and all elders, and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

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PREFACE

Dear learners,

This book is designed to help you understand the basic concepts and principles of Physics, and to attain the ability and confidence to apply them in real life situations and contexts.

This textbook will lead you through the frontiers of knowledge and awe–inspiring visuals to the depths of Physics. Your science laboratories will sprout new life when each sight raises the question in you - how and why? The ideas and concepts thus acquired will enable you to have lofty dreams to contemplate on and fulfill them through action.

Each activity in this book will change your perspective from **I** to **We**, upholding the notion that science is for the betterment of society. May you be able to raise new questions, share knowledge, arrive at the apt concepts, impart them to the society and lay the scientific foundation for countering superstitions with science.

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Certain icons are used in this textbook for convenience

 For further reading (Evaluation not required)

  Questions that may be raised by students

 Continuous assessment questions

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 Let's Assess

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THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a [1]**[SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC]** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the [2][unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949 do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

---

1. Subs. by the Constitution (**Forty**-second Amendment) Act, 1976, Sec.2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs. by the Constitution (**Forty**-second Amendment) Act, 1976, Sec.2, for "Unity of the Nation" (w.e.f. 3.1.1977)

5 Buoyant Force

Have you ever had similar doubts?

Let's do an experiment.

Fill three-fourth of a transparent bucket with water. Place a closed empty plastic bottle on the surface of the water in the bucket. What do you observe?

Try to immerse the bottle to the bottom of the bucket with your hand. Share your experience with your classmates.

- After fully immersing this bottle in water, remove your hand from the bottle. What do you observe?
- What made the plastic bottle rise to the surface of the water?
- Does the bottle experience force of gravity? If yes, in which direction?
- Why doesn't the bottle remain immersed in water?

Fig. 5.1

Let's consider another situation.

- When a bucket of water is drawn from a well, a decrease in weight is felt until it reaches the surface of the water. What is the reason for this weight loss?

Buoyant Force

Fill three-fourth of a bucket with water. Try lifting a mug filled with water from the bottom of the bucket as shown in the figure. Take it out of the water.

Fig 5.2

- What is the difference felt in the weight of the mug when it is inside and outside the water in the bucket? What could be the reason?

An upward force is experienced by the objects in liquids.

Is this upward force felt only in liquids? Let's examine.

- What happens to a helium filled balloon when it is set free in the atmosphere?

Even though a helium filled balloon has weight, isn't it because the upward force exerted by the atmosphere is greater than the weight of the balloon that it rises upwards?

Haven't you understood that objects experience an upward force not only in liquids but also in gases? In general, liquids and gases together are known as fluids.

From the previous activities, we understood that there are two types of forces acting on objects in fluids.

- The downward force on the object (the weight of the object)
- The upward force exerted by the fluid on the object

When an object is fully or partially immersed in a fluid, the upward force exerted by the fluid on the object is the buoyant force.

Find and record in your science diary instances where you experience buoyant force in everyday life.

- Air bubbles rising from water
-

Can we calculate buoyant force?

How can we measure buoyant force?

Let's do an experiment.

Take a spring balance calibrated in newton, a trough filled with three-fourth of water, a stone, an iron block and a glass slab.

Measure the weight of stone, iron block and glass slab using the spring balance and write it down in table 5.1. Then immerse each of them in water. Find their weight in water and complete the table.

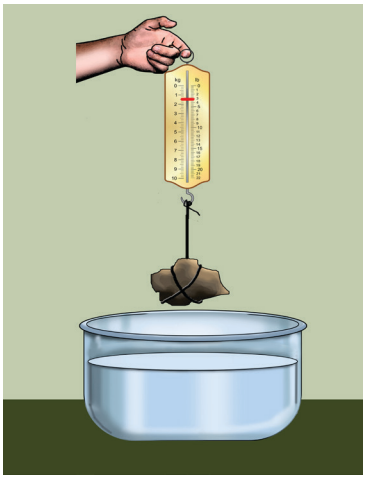


Fig 5.3 (a)

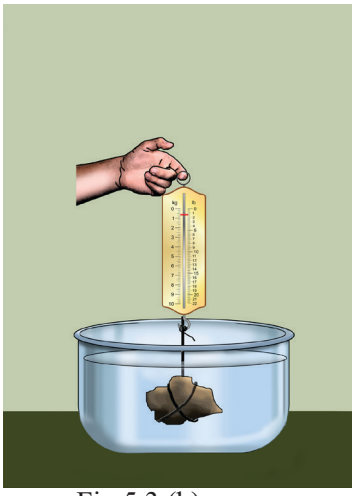


Fig 5.3 (b)

Object	Weight in air (W_1) N	Weight in water (W_2) N	Loss of weight in water = buoyant force ($W_1 - W_2$) N
Stone			
Iron block			
Glass slab			

Table 5.1

- Wasn't it due to the buoyant force that the objects experienced a loss of weight in water?

Isn't the relation between the loss of weight of an object in water and the buoyant force clear from the table?

When an object is in a fluid, the buoyant force experienced by the object is equal to the loss of weight of the object.

Can buoyant force felt by an object be the same in all liquids?

Factors Influencing Buoyant Force

Let's do an activity.

PhET→ Buoyant Force (KITE Ubuntu)

Take water, saturated salt water and glycerine in separate beakers.

Find the buoyant force felt by a 100 g slotted weight in these liquids, using a spring balance and complete the table.

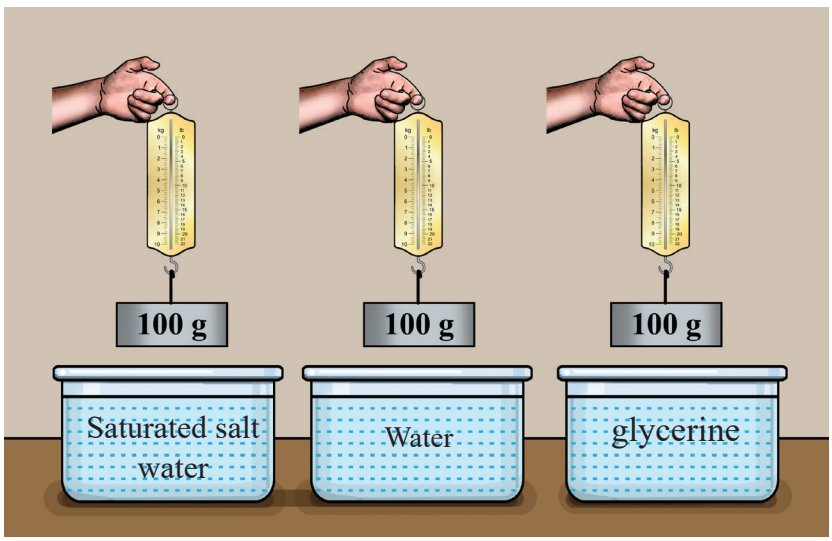


Fig 5.4

Weight of slotted weight in air $W_1 = mg$

$= 100\ g \times 9.8\ m/s^2$

$= 0.1\ kg \times 9.8\ m/s^2$

$= 0.98\ N$

Liquid	Weight of slotted weight in the liquid N	Loss of weight (buoyant force) N
Saturated salt water		
Water		
Glycerine		

Table 5.2

- What may be the reason for the difference in the loss of weight in different liquids?

Let's examine whether the loss of weight experienced by an object in different liquids is related to the density of the liquid.

Densities of some liquids that are familiar to us are given in table 5.3.

Liquid	Density kg/m^3 (approximately)
Water	1000
Saturated salt water	1025
Kerosene	810
Glycerine	1260
Coconut oil	920

Table 5.3

We know that the density of a substance is its mass per unit volume.

Analyse table 5.2 and table 5.3 and find the answers to the following questions.

- In which liquid did the slotted weight experience the greatest buoyant force?
- In which liquid did the slotted weight experience the least buoyant force?
- Which liquid given in the table has the highest density?
- Why did the slotted weight experience the greatest buoyant force in glycerine?
- As the density of the liquid increases, the buoyant force felt by an object

  increases/decreases

Hope you understood that the buoyant force varies with the density of a liquid.

Density of fluids is one of the factors affecting buoyant force exerted by the fluid.

Density matters !

The Dead Sea is a salt lake located between Israel and Jordan. Although it is not a sea, because of its size and exceptionally high salt content in water it is called 'sea'. Since the lake is much more saline than the ocean, it is denser than normal seawater. Its high salinity makes it unsuitable for the growth of plants and animals.

Explain the following situations and record in the science diary.

- **An egg sinks in freshwater but floats on saturated salt water.**
- **As a ship moves from freshwater lake to sea, it rises further.**
- **No one completely drowns in the Dead Sea.**

Do objects of the same weight experience equal buoyant force in the same liquid?

Let's see.

Take an iron block and a copper block of equal weight. Complete table 5.4 by finding their weights in air and water.

Iron block

Copper block

Fig 5.5

Object	Weight of object in air (W_1) N	Weight of object in water (W_2) N	Buoyant force ($W_1 - W_2$) N
Copper block			
Iron block			

Table 5.4

- Which object experienced more buoyant force?

  iron block/ copper block

- Which has greater volume?

  iron block/ copper block

Isn't it understood that the buoyant force experienced by an object fully immersed in a liquid depends on the volume of the object?

Factors influencing buoyant force experienced by an object fully immersed in a fluid are:

- density of the fluid
- volume of the object

When objects are immersed in liquids, liquid level rises. Is there any relation between the quantity of liquid that rises and the buoyant force?

Archimedes' Principle

Let's do an activity.

Take a stone and a glass slab. Find the buoyant force experienced by them in water. Immerse them one after the other in water taken in an overflow jar. Collect the water overflowed in a beaker.

Find the weight of the water overflowed (water displaced by the object).

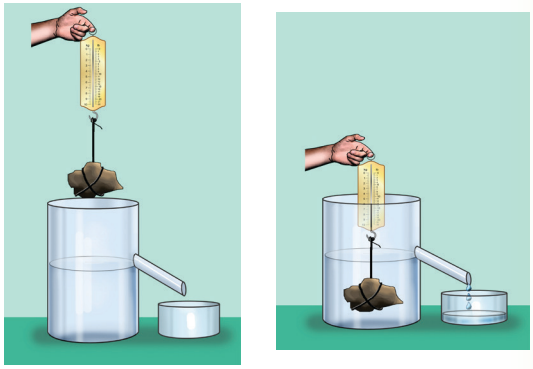


Fig 5.6

Object	Weight in air (W_1) N	Weight in water (W_2) N	Buoyant force (W_1-W_2) N	Weight of water displaced N
Stone				
Glass slab				

Table 5.5

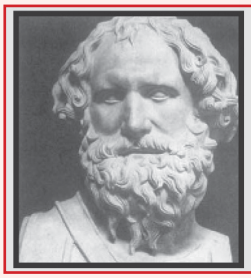
- What is the relation between the buoyant force experienced by the stone and glass slab in the water and the weight of the water displaced by each of them? Record your inference in the science diary.

It was Archimedes' who discovered this relation.

Archimedes' Principle

When an object is completely or partially immersed in a fluid, the buoyant force acting on the object is equal to the weight of the fluid displaced by the object. This is Archimedes' principle.

Archimedes



Archimedes was born in the port city of Syracuse in Southern Italy in 287 BC. There is an incidental story about him.

At the behest of King Heiro, the goldsmith made a gold crown. The king ordered Archimedes to test its purity. This puzzled him. He knew that to find the density of pure gold, it is enough to divide the mass by its volume. But the problem of finding the volume of the crown without damaging it perplexed him a lot. One day, he got into a tub full of water to have a bath. He noticed the water overflowing out of the tub. From this, he realized that to find the volume of an object it is enough to find the volume of water displaced by it. This revelation enabled Archimedes to confirm that the crown was adulterated by finding its volume and density.

Principle of Floatation

Haven't you understood the relation between buoyant force and weight of the fluid displaced by the body?

Repeat the experiment to prove Archimedes' Principle by replacing the stone and glass slab with a wooden block and a wax block. Complete table 5.6.

Object	Weight in air (W_1) N	Weight in water (W_2) N	Buoyant force (W_1-W_2) N	Weight of water displaced N
Wooden block				
Wax block				

Table 5.6

What is the relation between the weight of an object in air and the weight of the water displaced by it?

Principle of Floatation

When an object floats on a fluid, the weight of the object and the weight of the fluid displaced are equal.

The buoyant force experienced by an object immersed in a liquid is less than the weight of the object. But the buoyant force acting on a floating object is equal to the weight of the object.

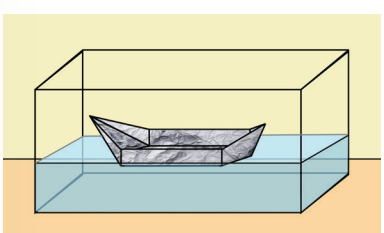


Fig 5.7 (a)

Make a boat with a piece of aluminium foil of approximate 15 cm length and 10 cm breadth. Place it on the surface of water. What do you observe?

Place a slotted weight of mass 100 g inside the boat. The boat will not sink. Why?

Roll the same aluminum foil firmly and try to place it on the surface of the water.

When the aluminium foil is in the shape of a boat it displaces water equivalent to its weight. When the slotted weight is placed in the boat, it displaces more water. The weight of the displaced water is equivalent to the weight of the boat

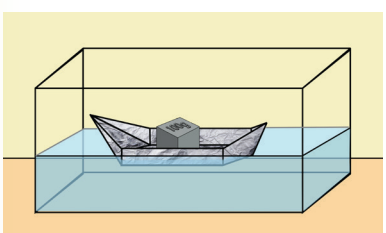


Fig 5.7 (b)

and the slotted weight together. The volume of water displaced by a boat-shaped aluminium foil is greater than that displaced by a rolled aluminium foil. Haven't you now understood the reason for the floating of the aluminium foil in the shape of a boat?

Now you can explain why a ship made of iron floats on water while a nail made of iron sinks in water.

? **A boat on a lake displaces 6000 kg of water. Calculate the buoyant force experienced by the boat.**

? **If an object weighs 0.45 kgwt in air and 0.31 kgwt when fully immersed in water, find the following.**

a) The loss of weight of the object.

b) The buoyant force.

c) Weight of water displaced.

Relative Density

- Do all liquids have the same density?

Based on the data given in table 5.3, classify kerosene, coconut oil, glycerine and saturated salt water by comparing with the density of water and complete the table.

Denser than water	Less dense than water

Table 5.7

The density of water is 1000 kg/m^3. In scientific studies, there are instances where the densities of substances are often compared with the density of water. The relative density of a substance indicates how many times the density of the substance is to the density of water.

$$\text{Relative density} = \frac{\text{density of substance}}{\text{density of water}}$$

Density of water and kerosene are 1000 kg/m^3 and 810 kg/m^3 respectively. If so,

$$\text{Relative density of kerosene} = \frac{\text{density of kerosene}}{\text{density of water}}$$

$$= \frac{810\ \text{kg/m}^3}{1000\ \text{kg/m}^3} = 0.810$$

Note that relative density has no unit.

? The density of copper is 8900 kg/m^3. What is its relative density?

? What is the density of mercury if its relative density is 13.6?

Hydrometer
Fig 5.8 (a)

How can we find the relative density of substances?

Let's familiarise ourselves with some devices that work on the principle of floatation.

Hydrometer

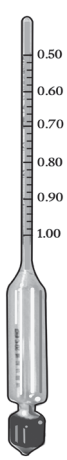
Hydrometer is a device used to measure the relative density of liquids. Using a hydrometer find the relative density of various liquids available.

Answer the following questions based on your observations.

- What is the reading of hydrometer in water?
- If the hydrometer is placed in a liquid denser than water, will the reading be above or below 1?

The relative density values calibrated on the hydrometer increase as it goes down [as shown in figure 5.8(b)]. Therefore, the relative density of liquids in which the hydrometer sinks lesser, will be higher.

- Don't you know that it is a crime to sell adulterated (water - added) milk? How will you know that water is added to milk? What is the device used for it?



Hydrometer (schematic diagram)
Fig 5.8 (b)

Lactometer

Lactometer is a device used to measure the relative density of milk [Fig.5.9 (a)]. Basically it is a hydrometer.

- Will the reading be the same if a lactometer is placed in pure milk and water-added milk? Why?
- Is it in pure milk or fat-removed milk that a lactometer sinks more? Why?
- Using a lactometer, how will you identify whether water is added to milk?

Fig 5.9 (a)

Fig 5.9 (b)

Adulteration of food is a crime like the sale of water-added milk. It is also a social menace. Prepare a poster and display it on the school notice board to conscientize the society.

Let's Assess

1. If an object weighs 0.2 kgwt in air and 0.19 kgwt when fully immersed in water,

   a) what is the loss of weight of the object in water?

   b) what is the buoyant force felt on the object?

2. A copper sphere and an iron sphere of the same diameter are immersed in water. Is the buoyant force experienced on both the same? Justify your answer.

   (density of copper is 8900 kg/m^3, the density of iron is 7800 kg/m^3)

3. Write down the reasons for the following statements.

   a) Toy balloons filled with helium gas rise in the air and balloons filled with carbon dioxide go down.

   b) A ship plunges less in water when the weight is unloaded at the port.

4) The use of life jackets in boats is mandatory. Explain it in terms of buoyant force.

5) The density of saturated salt water is 1025 kg/m^3. Calculate its relative density.

6) The illustration (Fig. 5.10) shows how an object is suspended in air and dipped in a liquid in different ways using a spring balance.

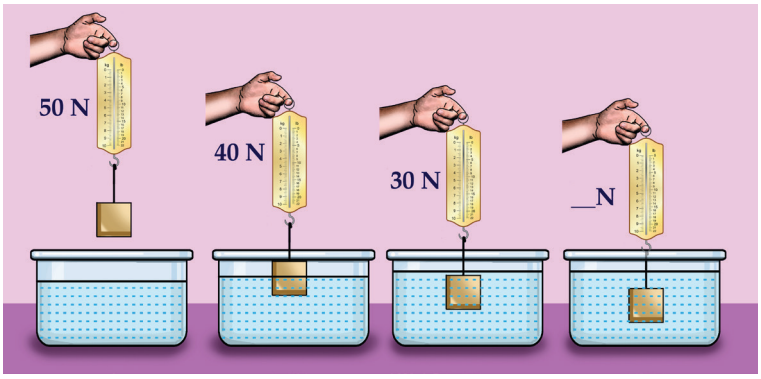


Fig. 5.10

   a) What is the reason for the difference in buoyant force in figure 2 and 3?

   b) What is the reading of the spring balance in figure 4? Why?

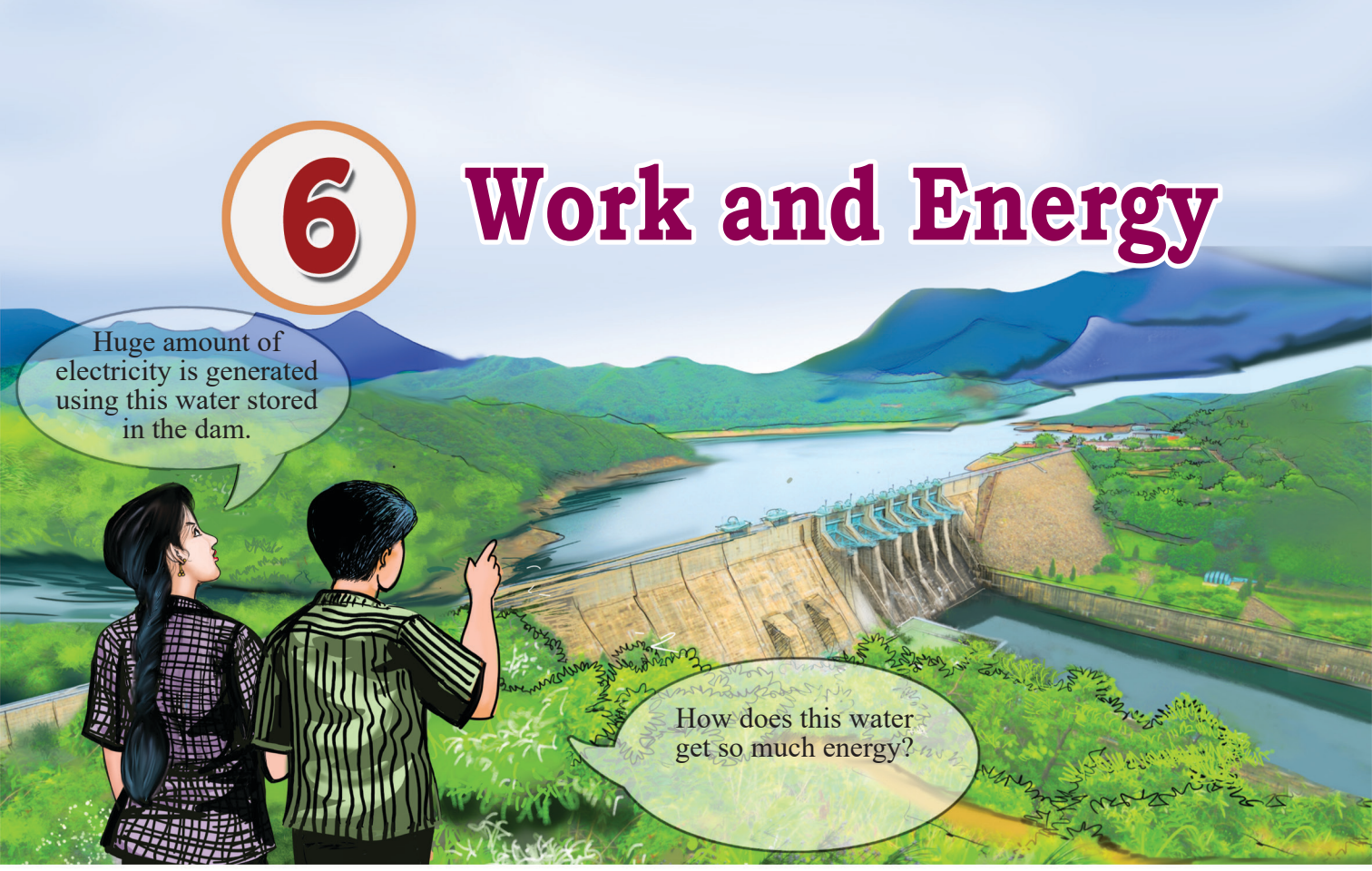
7) An object weighing 800 N in air, floats on water. What is its weight in water? What is the weight of the displaced water?

Extended Activities

1. Make a hydrometer using a test tube, lead shot, wax and calibrated paper. Mark the relative density of water by immersing it in pure water. Compare this value with the relative density of other liquids.

2. Make a lactometer. Find the relative density of milk in a few milk pails at your nearest milk society. Compare it with the society's milk price chart.

6 Work and Energy



Let's see how this is possible.

The following figures depict activities familiar to us in our daily life. Analyse the situations and complete the table 6.1.

Fig. 6.1 (a)

Fig. 6.1 (b)

Fig. 6.1 (c)

Fig. 6.1 (d)

Situation where force is applied	Object on which force is applied	Is there displacement for the object? Yes/No	Is there displacement for the object in the direction of applied force? Yes/No
Loading goods onto a lorry	Load	Yes	Yes
Trying to push a huge rock	Rock	No	
A trolley being pushed in a supermarket			
A man standing with a load on his head			

Table 6.1

From table 6.1 it is understood that there is no displacement in the direction of the applied force in all these situations.

Work

Work is said to be done by a force if there is a displacement for the object in the direction of the applied force.

- In table 6.1, identify the situations where work is done.
- Identify the situations where work is not done.

Can we calculate the quantity of work done?

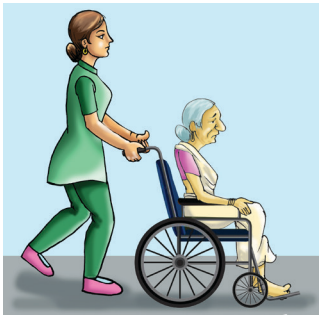
Measure of Work

Haven't you seen patients being taken in wheelchairs in hospitals?

Observe the situations depicted in figure 6.2 where an attender shifts patients to a distance of 10 m along a level verandah.

Here the applied force varies according to the weight of the patients. Isn't it because the frictional force on the wheelchair increases as the patient's weight increases?

Patients on the wheel chair are to be shifted to a distance of 10 m. A force of 40 N is to be applied on the wheel chair in situation 1.The force needed is 70 N in situation 2. In both the cases the wheelchair was taken at the same speed along the same path. The displacement of the wheelchairs is also the same.



Situation 1

Situation 2

Fig 6.2

When we move objects across a floor on a horizontal plane, we are applying a force against the force of friction. Hence we are doing work against the force of friction.

- In which situation was more work done? Why?

  situation 1/ situation 2

- Here, which factor influences the quantity of work done?

  force / displacement

If the patient in the second situation has to be shifted through a distance of 20 m under the same conditions, the quantity of work done will increase.

- Here which factor influences the quantity of work done?

  force/displacement

From the situations discussed above, write down in your science diary, the factors influencing the work done.

- Force
-

Work done is measured as the product of force applied and the displacement of the object in the direction of the applied force.

When a force F newton is continuously applied on a body and if the displacement in the direction of the applied force is s metre, then the work done by the force on the body will be,

Work done = force × displacement

W = Fs

The unit of work = unit of force × unit of displacement

= - - - - - - -

James Prescott Joule

Place of Birth : England

Life Time : 1818 – 1889

Major contributions and achievements :

Conducted fundamental researches on the properties of heat and formulated the equation related to the heat produced when electricity flows. Played an important role in formulating the theory of thermodynamics by connecting mechanical energy and heat energy. In 1850 he was selected as a fellow of the Royal Society.

You have understood that the unit of work is newtonmetre. It is known as joule in SI unit, named in honour of the scientist James Prescott Joule.

If a force of 1 N moves an object through a distance of 1 m in the direction of force along a horizontal surface, calculate the work done by the force.

$W = F \times s$

Force $F = 1$ N

Displacement $s =$ - - - -

Work done $W = F \times s =$ - - - $\times$ - - - - = - - - -

If a force of 1 N is applied on an object and the object is displaced by 1 m in the direction of the force, then the work done on the object by the force is 1 J.

Haven't you understood how to calculate the work done when a force is applied on an object?

How do we calculate the work done while lifting objects?

Shouldn't force be applied against gravity while lifting objects?

Fig. 6.3

Work done against gravity

Observe the figure showing a crane lifting a container of mass m kg to a height h metre.

The weight of the container is mg newton.

The container can be lifted only if at least an equal force (mg newton) is applied in the upward direction.

- Force exerted by the Earth on the container = ————
- Force to be applied by the crane on the container = ————

Quantity of work done by the force exerted by the crane on the container

$W = F \times s$

Here the displacement, s is the height. Hence $s = h$

Work done, $W = F \times s = mg \times h = mgh$

Work done in lifting objects against the force of gravity, W = mgh

Calculate the quantity of work required to lift an object of mass 100 g to a height 1m (g = 10 m/s^2).

A barrel of mass 50 kg is to be loaded onto a lorry. Platform of the lorry is at a height of 2 m from the ground level (g = 10 m/s^2).

a) **Calculate the work done against the force of gravity when the barrel is loaded onto the lorry.**

b) **What is the work done against the force of gravity if it is rolled to a height of 2 m using an inclined plane of length 5 m?**

c) **Does the work done against gravity depend on its path of motion? yes/ no**

Negative Work

A child pulling a box kept on a table is depicted in figure 6.4. Observe it and complete the table.

Here the forces acting on the object are force of gravitation – A, force of friction – B, the force applied by the table on the box – C and the force applied by the child on the box – D.

Force experienced on the table	Direction of force
Force applied by the child	P → D
Force of gravitation	
Force of friction	
Force applied by the table on the box	

Table 6.2

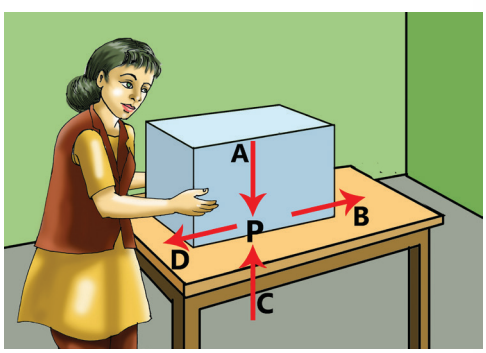


Fig. 6.4

- In which direction will the box move?

(P → D, P → A, P → C, P → B)

- In which direction of the force did the box get displaced?

- Against which force did the box get displaced?
- Why did the force of gravity and the force applied by the table cause no displacement to the box?

The box is displaced in the direction of the force applied by the child. So, we can consider that this force has done a work on the box. Such a work is positive work. The displacement of the box is in the opposite direction to the force of friction. Here work done by the frictional force on the box is considered as negative work.

If the displacement of an object is in the direction of the force, then the work done by the force on the object is positive.

If the displacement of an object is opposite to the direction of the force, then the work done by the force on the object is negative.

? **Write down whether work is positive or negative in each of the following situations,**

- **The work done by the force of gravity on a stone when it is thrown up.**
- **The work done on the stone by the applied force when we throw a stone upwards.**
- **The work done by the force applied by a crane on the object while lifting it.**
- **The work done on an object by a crane when the object is lifted up.**
- **The work done by the force of gravity when a coconut falls down.**

? **In a supermarket a shopper pushes a trolley to a distance of 16 m by applying a force of 95 N continuously. Calculate the work done.**

We have familiarised ourselves with a few types of work. Don't we get tired while doing various activities? Isn't it because we utilise energy to do work?

Is there any relation between energy and work?

Energy

Write down examples of different forms of energy you are familiar with.

- Electrical energy
- Mechanical energy
- Heat energy
-

Aren't these the different forms of energy that are used to do work?

If so, what is energy?

> Energy is the ability to do work.

In which unit is the quantity of energy expressed?

It is energy that is transformed into work when we do different activities. So the unit of work is the unit of energy.

The SI unit of energy is joule (J).

For indicating the quantity of energy in food, we also use the unit kilocalorie.

What is the relation between joule and calorie?

1 cal (calorie) = 4.2 J

1 kcal = 4200 J

(1000 calorie = 1 kcal)

? **The quantity of energy contained in a ripe mango is approximately 840 kJ. Express this energy in calorie.**

Among the different forms of energy, let's examine mechanical energy in more detail.

Mechanical Energy

Mechanical energy is the energy that objects acquire by virtue of their motion, position or configuration.

There are mainly two types of mechanical energy – potential energy and kinetic energy.

Potential Energy

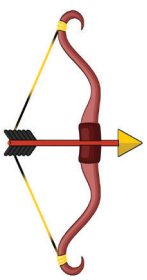


Fig. 6.5 (a)

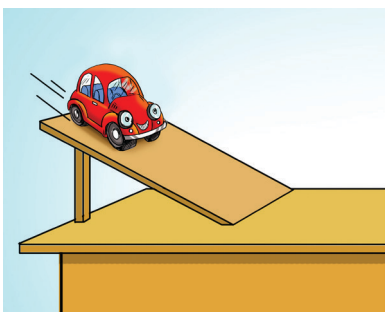


Fig. 6.5 (b)

Note the arrow and the toy car in the images. What is peculiar about their positions?

- What would happen if the arrow from the arched bow and the car at a height are released?
- Where does the energy for the arrow to move come from?

Isn't the unique configuration caused by the tension on the string and the arched bow give the arrow its energy?

- How does the toy car get energy to move?

Isn't it due to the position of the car?

Didn't these objects get energy due to their position or configuration?

Such energy is potential energy.

Potential energy is the energy possessed by objects due to their position or configuration.

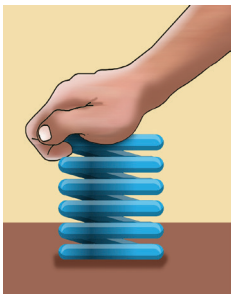
You have understood that potential energy is of two types.

- potential energy due to position
- potential energy due to configuration

Classify the following situations suitably on the basis of the potential energy acquired.

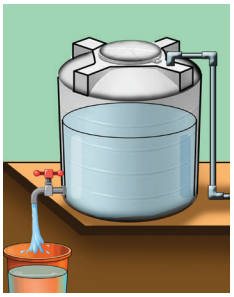
Energy possessed by a coconut on a coconut tree

Fig. 6.6 (a)



Energy stored in a compressed spring

Fig. 6.6 (b)



Energy possessed by the water stored in a tank

Fig. 6.6 (c)

Energy in the pole due to its bending during pole vault jump

Fig. 6.6 (d)

potential energy due to position	potential energy due to configuration

Table 6.3

How can we calculate the potential energy of an object due to its position?

The work done against the force of gravity is the cause of potential energy due to its position.

The potential energy due to its position is equal to the quantity of work done on the object against the force of gravity.

Potential energy due to position, $\mathbf{E_p = mgh}$

Here m is the mass and h is the height from the ground.

- An object of mass 50 kg is lifted to a height 8 m from the ground.
  a) What is its potential energy when it is on the ground?

Potential energy is always calculated relative to a reference level. By considering the potential energy of a body at the reference level as zero, its potential energy at each position is calculated. The ground level is taken as the reference while measuring height. Therefore, the potential energy at ground level is usually assumed as zero.

b) Calculate the potential energy when the body is at a height of 8 m.

The mass of object, m = ----------

Acceleration due to gravity, g = 9.8 m/s^2

The change of position of the body (displacement or height) against the force of gravity, h = ----------

Potential energy, E_p = ----------

E_p = ---------- × ----------

= -------

Kinetic energy

Fig. 6.7 (a)

Fig. 6.7 (b)

Haven't you seen huge trees falling, roofs of buildings being blown off during cyclonic storms and collapsing of buildings due to landslides?

Is it not because of their motion that wind and water are able to do work?

Kinetic energy is the energy possessed by an object by virtue of its motion.

Factors influencing Kinetic Energy

Let's do an activity.

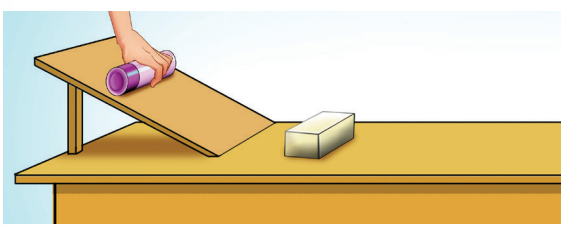


Fig. 6.8

Roll down a cylindrical tin on an inclined surface so that it hits a rectangular block as shown in figure 6.8.

Observe the distance travelled by the rectangular block.

After filling the same tin with soil, repeat the activity with the rectangular block in the original place.

- Will the rectangular block move farther? What could be the reason?

It is because of the increase in mass that the rectangular box moved farther.

Now you have understood that kinetic energy increases with increase in mass.

- Is there any other factor that affects kinetic energy?

Let's repeat the experiment by increasing the speed of the tin.

- Repeat the experiment by rolling down the same tin filled with soil from a greater height (by increasing the height of the inclined plane). What do you observe?

Here the rectangular block moved a longer distance due to the increase in velocity of the soil-filled tin.

Now write down the two factors that influence kinetic energy.

- Mass of the object (m)
-

Can kinetic energy be calculated?

Work, $W = Fs$

According to Newton's second law of motion, $F = ma$
Hence work, $W = Fs = (ma)\, s$

From the equations of motion, we have $v^2 = u^2 + 2as$

If initial velocity $u = 0$ then

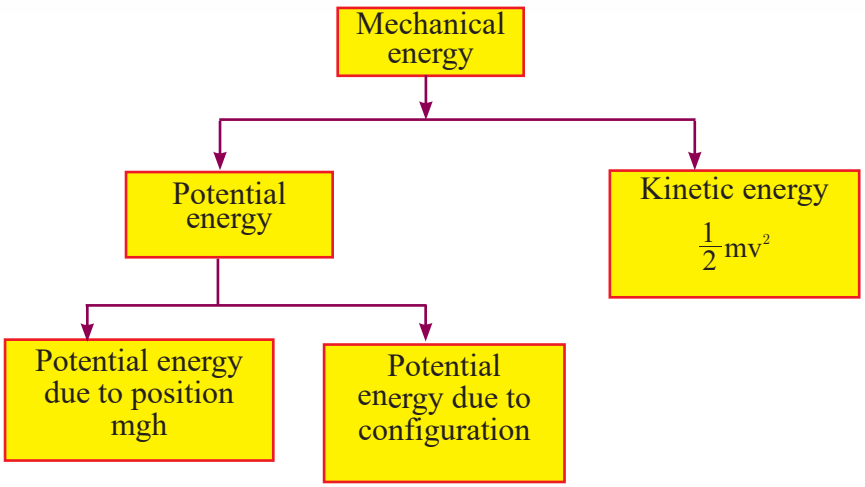
$$v^2 = 2as$$

$$as = \frac{v^2}{2}$$

$$W = mas = \frac{mv^2}{2} = \frac{1}{2}mv^2$$

Kinetic energy of the object, $\mathbf{E_k = \frac{1}{2}mv^2}$

If m is the mass in kg and v is the velocity in m/s then E_k represents the kinetic energy in joule (J).



Complete the table 6.4 associated with the kinetic energy of objects.

Mass of the object (m) kg	Velocity of the object (v) m/s	Kinetic energy $E_k = \frac{1}{2}mv^2$ J
10	2	20
5	2	
10	4	
10	1	

Table 6.4

- Based on table 6.4, write down the changes in kinetic energy in the following cases.

  a) When the mass is doubled

  b) When the velocity is tripled

  c) When the velocity is halved

A motorcyclist is travelling in a straight line at a speed of 10 m/s. The combined mass of the motorcycle and the passenger is 300 kg.

a) What is the kinetic energy of the motorcycle and the passenger?

b) What is the kinetic energy if the speed is doubled?

An athlete throws a shot of mass 6 kg with a speed 12 m/s. What will be the kinetic energy of the shot?

A ball of mass 0.5 kg is at a certain height above the ground.

a) If the potential energy of the ball is 98 J, how high will the ball be ? ($g = 9.8\ m/s^2$)

b) What will be the kinetic energy of the ball just before hitting the ground, if it is allowed to fall freely?

Hasn't the potential energy of the ball changed into kinetic energy?

Can all forms of energy be converted from one form to another?

Energy Transformation

We can light a bulb using electricity. Don't we pump water using a motor pump?

We see that in our daily life energy can be converted from one form to another. Don't we use a variety of machines to make it easier? Write down the names of some machines and energy conversion in them.

- An electric motor converts electric energy into mechanical energy.
- Petrol car converts chemical energy into kinetic energy.
-

You are familiar with various types of toys.

Have you noticed how energy conversion is utilised in each of these?

Balloon Toy Car

Let's make a balloon toy car as shown in figure 6.9.

- How does the balloon get the required energy /force to move the toy car?
- What change happens to the rubber of the balloon when it is inflated?

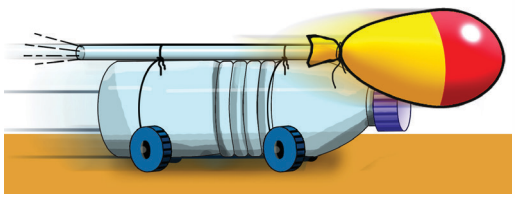


Fig. 6.9

- Which type of energy is possessed by an inflated balloon?
- What change in energy occurs when the car moves?

Here the potential energy of the balloon is converted into kinetic energy of the toy car.

Make a car like this.

What are the essential features required to make your toy car better?

Compare the merits of your car with those of others.

Does the quantity of energy decrease during energy conversion?

Law of Conservation of Energy

Observe figure 6.10

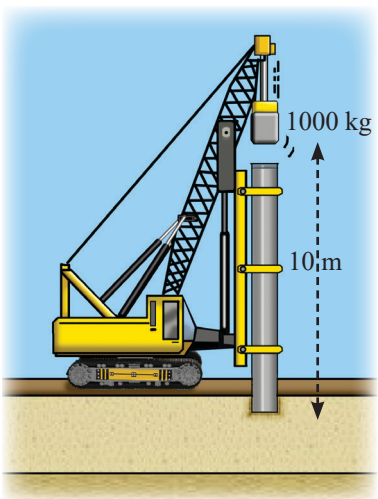


Fig. 6.10

- Have you noticed the piling process involved in the construction of buildings and bridges for basement reinforcement?

A pit is formed as a result of the powerful hammer force from the machine hitting the pile.

The potential energy of the hammer can be calculated when the hammer is at a height as shown in figure 6.10.

Mass of hammer, m = 1000 kg

Acceleration due to gravity, g = 9.8 m/s^2

Height of hammer, h = 10 m

$E_p = mgh$

- Potential Energy = ------ × ------- × -------

= ------

The hammer has no kinetic energy at the initial position since it is not in motion.

PhET→ Energy Skate Park

- Hence total energy = potential energy + kinetic energy

  = - - - - - - + - - - - - -

  = - - - - - - J

When the hammer strikes the pile, the potential energy of it changes to kinetic energy. Now let's consider the top end of the pile reaching the ground level. When the hammer touches the pile at the ground level the velocity with which the hammer hits the pile is the maximum. Hence the kinetic energy of the hammer is also the maximum.

Kinetic energy is $\frac{1}{2}$ mv^2

From the equations of motion we can write $v^2 = u^2 + 2as = u^2 + 2gh$ (since a = g and s = h)

Initial velocity of hammer, u = - - - - - -

Therefore, v^2 = - - - - - -

Kinetic energy = $\frac{1}{2}$ mv^2 = - - - - - -

- The total energy of the hammer just before it touches the pile at the ground level = potential energy of the hammer just before it touches the pile at the ground level + kinetic energy of the hammer just before it touches the pile at the ground level

  = - - - - - - + - - - - - -

  = - - - - - -

- What conclusion can we draw from comparing the total energy when the hammer is at the top and the total energy at the instant of touching the ground?

On comparing these, it is understood that one form of energy can be converted into another form without loss of energy.

Some characteristics of energy are clear to you, aren't they?

Energy can neither be created nor destroyed. One form of energy can be converted into other forms of energy without loss or gain of energy. This is the law of conservation of energy.

What are the similarities between work and energy?

- Both work and energy are scalar quantities.
-

From where do we mainly get the energy needed for our various activities?

Observe figure 6.11 and understand that the main source of energy on the Earth is the Sun.

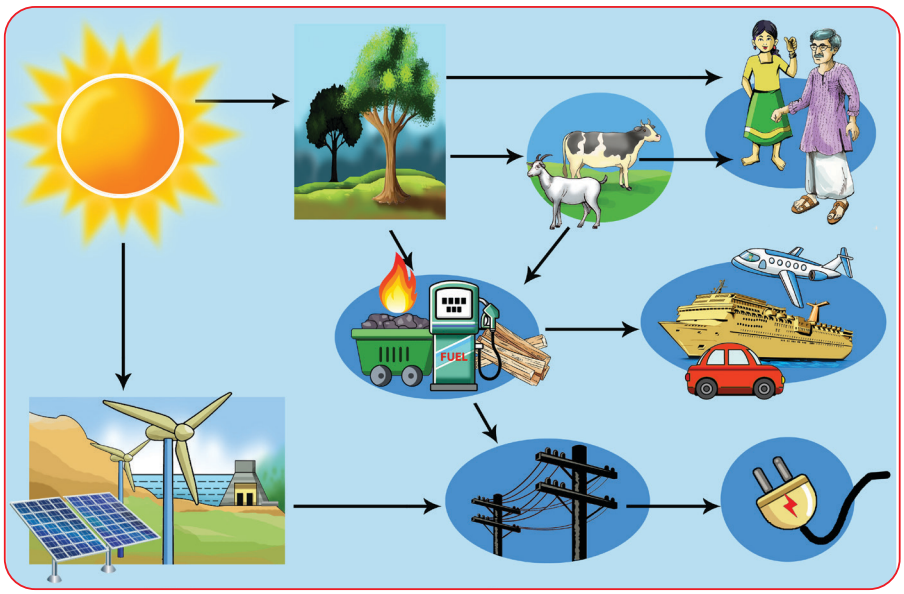


Fig. 6.11

- How do plants use solar energy?
- How is the energy we get from food related to the Sun?

Write down the energy change that takes place here.

- Is the energy production in power plants related to the Sun?
- How is the energy in petrol and diesel related to the Sun?

Observe the schematic diagram of a hydroelectric power station.

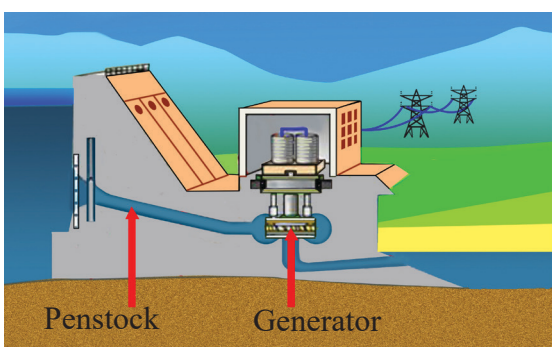


Fig. 6.12

- Which energy is possessed by the water in the reservoir?
- How did the water in the reservoir get this potential energy?

- A pipe that carries water downwards is called penstock. Which energy is possessed by the flowing water?

A generator converts this kinetic energy into electric energy. Reservoir stores a large quantity of water. So it can serve as a huge source of energy.

Now you have understood, from where the water in the reservoir acquired its energy.

Complete the energy conversion starting from the energy of water in a hydroelectric power plant to the energy obtained when lighting a bulb in a house.

Water in the dam	Water flowing down	When the turbine of the generator rotates	When the generator works	When the bulb glows
Potential energy	Kinetic energy and potential energy	Mechanical energy	.....	.....

Table 6.5

Bulbs are not the only devices used in our houses.

Name some electric devices.

- Motor
-

- Do they all use electric energy at the same rate?

Power

Let's do an activity.

A certain number of books (ten books) are stacked one above the other on the floor.

Select four students from the class. Let's find out who among them can quickly stack the books from the floor one above the other on the table.

Each selected child picks up the books on the floor one by one and stacks them one above the other on the table. Using a stop watch, find the time required to place all the ten books on the table and record it in the table 6.6.

Acceleration due to gravity, g = 10 m/s^2

No	Name	Time s	Books (Total mass) kg	The height to which the books are to be raised (h) m	The quantity of work (mgh) J	Rate of doing work $\frac{\text{Work done}}{\text{Time}}$
1						
2						
3						
4						

Table 6.6

James Watt

Place of Birth : Scotland in Britain

Life time : 1736 – 1819

Major contributions :

While trying to repair the Newcomen engine, which had been existing since 1764, a high quality steam engine was designed. James Watt is considered the scientist, who helped revolutionise the Industrial Revolution in Europe because he discovered and harnessed the potential of the steam engine which was limited to mines.

- Is the quantity of work done by all the children the same?
- Which child completed the work first?
- Who has done more work in one second?

Power is the work done in one second.

Power is the quantity of work done per unit time or power is the rate of doing work.

$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$

$$P = \frac{W}{t}$$

Unit of Power = ... / .....

= .....

The SI unit of power is named as watt to commemorate the scientist James Watt. Its symbol is W.

The units megawatt and kilowatt are also used while measuring larger values.

1 kW = 10^3 W = 1000 W

1 MW = 1,000 kW = 10^6 W = 10,00,000 W

The power of vehicles and motors are expressed in horsepower also.

1 HP = 746 W

Write down the names of some electric appliances we use in our houses and their marked power.

Calculate the power of an electric iron if 15 kJ work is done in 20 s.

Let's Assess

1) Which one of the following quantities has the same unit as that of work?

   a) power b) energy c) force d) displacement

2) Which of the following pairs are scalar quantities?

   a) time and energy b) force and power

   c) speed and acceleration d) displacement and velocity

3) Which of the following is the unit of power in terms of the fundamental units metre, kilogram and second?

   a) kgm^2/s^3 b) kgm/s c) kgm/s^2 d) kgm^2/s

4) An object of mass 2.4 kg is kept on a level surface. On applying a force of 50 N, the object moves 8 m in the direction of the force. Calculate the quantity of work done.

   a) 40 J b) 400 J c) 50 J d) 17.6 J

5) The figure depicts a body of mass 20 kg lifted to a height 5 m using a pulley. If the work done is 1020 J, answer the following questions. (Acceleration due to gravity = 10 m/s^2)

   a) What is the work done here if the force of friction of the pulley is not considered?

   b) Calculate the work done against the friction of the pulley.

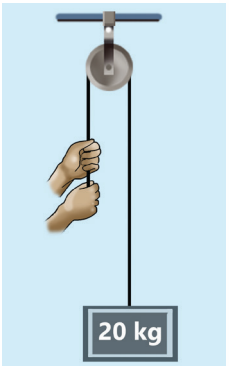


Fig. 6.13

6) An electric motor pumps 186.5 kg of water into a tank at a height of 8 m in 10 s ($g = 10\ m/s^2$).

a) Calculate the power of the motor.

b) Express this in horsepower.

c) How much time will it take to fill the same quantity of water if the power of the motor is halved?

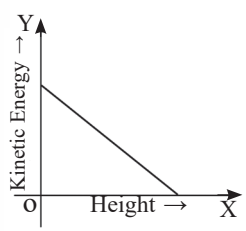
7) The mass of a body is 4 kg. When a continuous force of 3 N is applied to this object towards the east, there is a displacement of 6 m in the direction of force. Then the same force (3 N) is continuously applied towards south and the displacement is 5 m in the direction of this force.

a) Calculate the work done when the object is moved towards south.

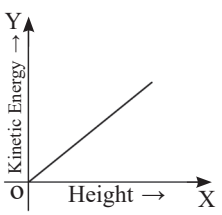
b) Calculate the total work done on the object.

8) If an object is thrown vertically upwards, its potential energy and kinetic energy will change.

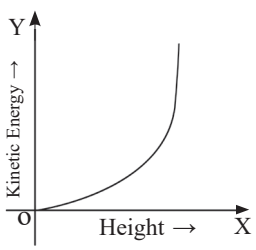
Which of the following is the correct graph related to kinetic energy? Justify your answer.



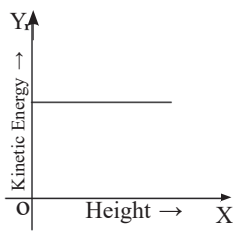
Graph 6.1 (a)



Graph 6.1 (b)



Graph 6.1 (c)



Graph 6.1 (d)

9) The Vikram lander module of Chandrayaan III has a mass of 1752 kg.

a) What will be its potential energy when it reaches a height of 100 m from the lunar surface? (Acceleration due to gravity on moon is $1.6\ m/s^2$).

b) If the same Vikram module is located at a height 100 m from the Earth's surface then what will be its potential energy? ($g = 10\ m/s^2$).

10) A person of mass 80 kg is standing on a suspended platform of mass 170 kg to paint the outer wall of a flat. The quantity of work done by the motor to raise him and the platform to this height is 150 kJ. How high is the platform? ($g = 10\ m/s^2$).

11) The figure 6.14 shows two cars of the same mass and a lorry of double the mass moving along a straight road. Observe the figure and answer the following questions.

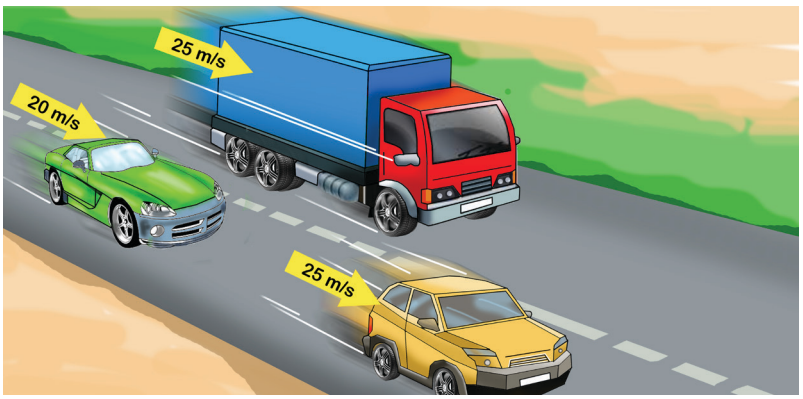


Fig. 6.14

a) Will the kinetic energy of both the cars be the same? Justify your answer.

b) Is the kinetic energy of the lorry and the car in front the same? Why?

c) Calculate the kinetic energy of the car at the back if its mass is 1800 kg.

12) Analyse the figure and answer the following questions.

A indicates the top most position of a building. The three stages of a ball, which is at rest falling freely from A are depicted.

a) What is the kinetic energy at A?

b) What is the potential energy at A?

c) What is the total energy at A?

d) What is the kinetic energy at C?

e) What is the potential energy at C?

f) What is the total energy at C?

g) What change in energy has taken place as the ball falls? Describe.

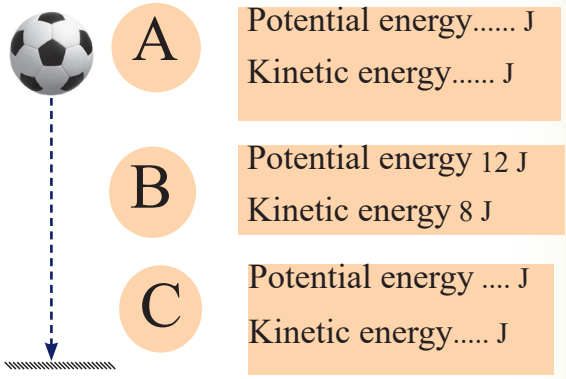


Fig. 6.15

13) Using a conveyor belt that transports construction material to the top of a building, 5 sacks of cement of mass 50 kg each are brought to a height of 8 m in 16 s. Calculate the power of the motor of the conveyor belt ($g = 10\ m/s^2$).

14) Babu and Raju have brought the materials for house construction to the top of a 15 m tall building. The details are given below.

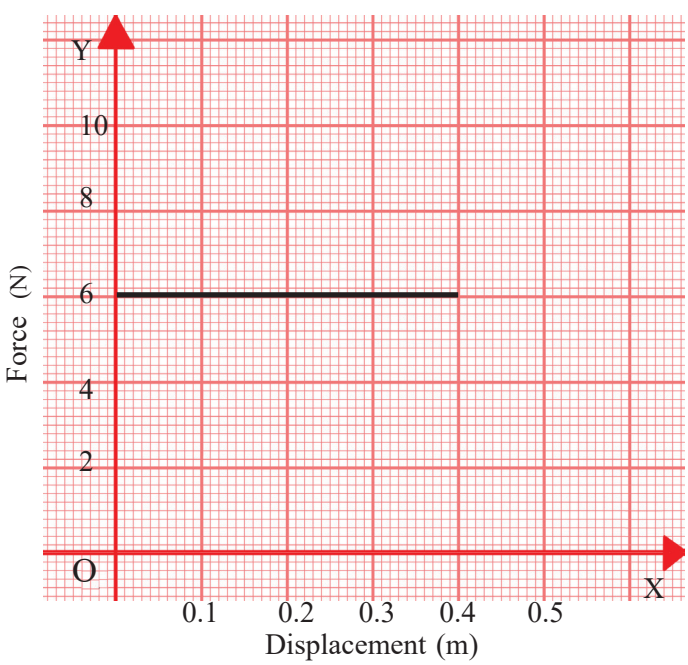
	Weight	**Time taken to lift the load to the height**
Babu	600 N	300 s
Raju	400 N	200 s

Table 6.7

a) Find out who did more work.

b) If it is said that Babu has more power, will you agree with it? Explain.

15) Observe the graph between the force and displacement of a body.



Graph 6.2

a) From the graph, find the magnitude of the force exerted on the object.

b) From the graph, find the maximum displacement caused by the applied force.

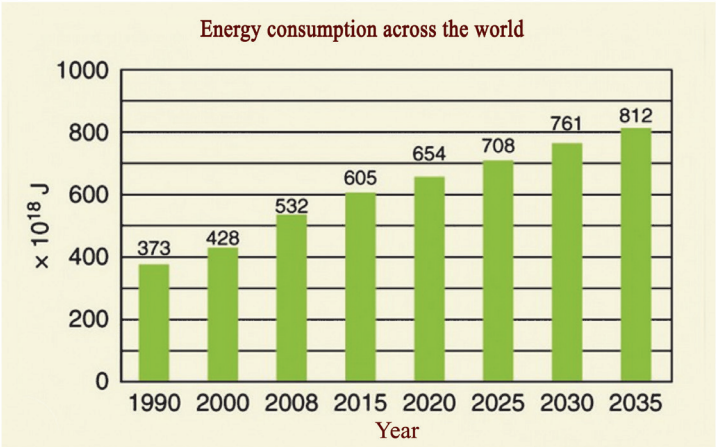
c) What is the method to find the quantity of work using graph? Find the area under the graph and check whether it is equal to the work done.

Extended Activities

1) The development of science and technology has influenced the records in the field of sports. There has been an enormous change in the development and design of materials of the pole used in pole vault, sports shoes, sportswear etc. This has greatly influenced the result in competitions. Collect more information related to this and make a note of it.

   (For example, compare the change in materials used in making the pole and the change in new heights cleared by the pole vaulters.)

2) Analyse the chart on energy consumption across the world. If development is to continue in the same pace, energy consumption has to increase.



Graph 6.3

Prepare a seminar paper on the steps to be adopted to meet the increased demand for energy.

3) Check the power of electric appliances in your house. Prepare short notes on steps to be taken to make the energy consumption scientific. Discuss in class and prepare a notice listing scientific methods to reduce electricity consumption.

4) When modern cars are built, the front and rear bumpers are designed to break quickly. This is essential for the safety of passengers. Using strong crash guards at the front is a threat to the lives of the passengers.

   Prepare a note explaining this based on the work - energy concepts we have learned.

7 Electric Current

Have you noticed the doubt the child had when she observed a battery-operated LED circuit at the school science fair?

You have learned some facts about electricity and electric charge in the previous classes. You know that objects acquire electric charge when rubbed against each other due to the transfer of electrons.

- What are the electric charges that objects acquire when rubbed against each other?
- What is the charge of electrons?
- What is the unit of electric charge?

Connect a charged capacitor (6 V, 500 μF) to an LED as shown in figure 7.1.

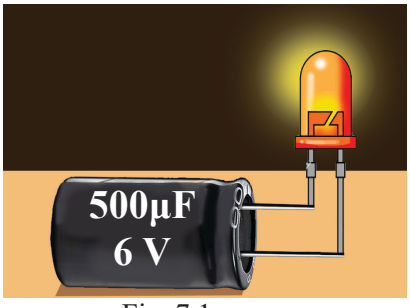


Fig. 7.1

- What is your observation?
- What happens to the electric charge in the capacitor when it is connected to an LED?
- What could be the reason for the LED not glowing continuously in this arrangement?

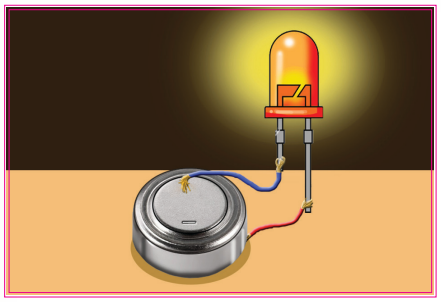


Fig. 7.2

Capacitor

A capacitor is a component used to store electric energy. It produces a momentary current flow by discharge through the external circuit when required. Capacitors are used in most of the electronic devices. The capacitor will be charged when the positive and negative terminals of a capacitor are connected to the positive and negative terminals of a cell respectively for a short interval of time.

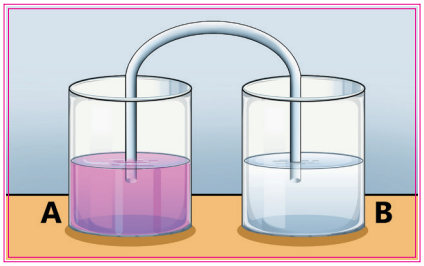


Fig. 7.3

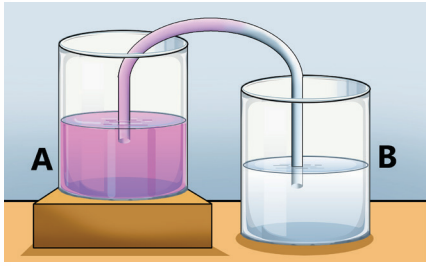


Fig. 7.4

Let's do another experiment. Connect an LED as shown in figure 7.2 to a button cell used in calculators and other electronic devices. What is your observation?

- Does the LED glow continuously here?

Haven't you understood that in the first experiment there is a momentary flow of electric charge and in the second a continuous flow?

Flow of charges produce an electric current through a circuit. Let's do some experiments to understand more about electric current.

Take equal quantity of water in two identical containers A and B. Add any colour to one of the containers. Fill a plastic tube (siphon) with water and dip it as shown in the figure 7.3.

- Does water flow from container A to B?
- Is the gravitational potential due to the height of the water level in the two containers the same?

  Same / different

Repeat the experiment by keeping the container A slightly elevated.

- Now, does the water flow from container A to B?

It is understood that in the experiment shown in figure 7.3 water did not flow because the water level in the two containers is the same. But in the experiment in figure 7.4 water flowed from A to B because of the difference in the water level.

Observe two more situations.

Situation 1

An iron rod touches the flame of a candle as shown in figure 7.5.

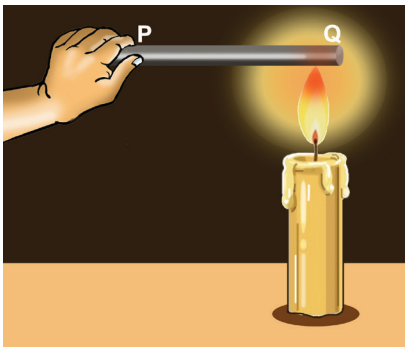


Fig. 7.5

- On which part of the rod will the temperature rise first, as soon as it touches the flame?

  P / Q

- What is the direction of the flow of heat through the rod?

From P to Q / From Q to P

Situation 2

A tube filled with air to its maximum is shown in figure 7.6.

Fig. 7.6

- Where is the air pressure greater?

  inside the tube / outside the tube

- If the valve of the tube is opened, what is the direction of the air flow?

Tabulate the inference drawn from the above activities.

Situation	Direction of flow
Water flows	
Heat flows	from a point of higher temperature to a point of lower temperature
Air flows	

Table 7.1

The flow of water occurred because the two containers are placed at different heights. Similarly, heat flow occurred because there were two points with different temperatures. Air flow occurred because there were two regions having a difference in pressure.

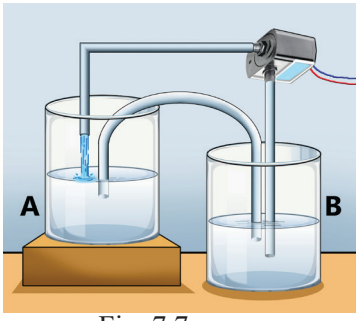


Fig. 7.7

Observe figure 7.7.

While using the siphon, the flow of water from container A to B is possible only until the water levels in both containers become equal.

A pump is used to pump back the water from container B to A. The pump works to keep the rate of flow of water from B to A same as that from A to B. Is there a continuous flow of water while the pump is working?

- What may be the reason?

For the continuous flow of water, a difference in water levels in containers A and B has to be maintained. This difference is maintained by using a pump which acts as an external energy source.

How is the flow of electric charges made possible through a circuit?

Potential Difference

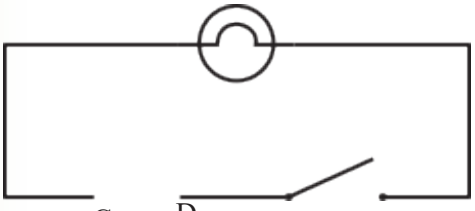


Fig. 7.8

- Observe the circuit in figure 7.8. Does the bulb glow when the switch is turned on?
- What may be the reason?

For the bulb in the circuit to glow continuously, there must be a flow of electric charge through the bulb. Doesn't this require an external source sufficient to maintain a potential difference between the points C and D?

Electric potential is the potential energy acquired by unit charge placed in an electric field. It can also be denoted as potential .

The potential difference between two points in a circuit is the quantity of work done in moving a unit charge between these two points.

A source of electricity is a source of energy used to maintain a potential difference between two points in an electric circuit.

Electro motive force (emf) is the potential difference between the terminals of a cell when no current is drawn from it (open circuit). This is the maximum potential difference that can be obtained from the source. Therefore the source of electricity is also called the source of emf.

The potential difference between any two points in a current flowing circuit is also called the voltage. Unit of both voltage and potential difference is volt (V). Potential difference is measured using voltmeter.

If the work done to move one coulomb (1 C) of electric charge from one point to another is one joule (1 J), then the potential difference between these two points is said to be one volt (1 V).

$$\text{Potential difference (V)} = \frac{\text{Work done (W)}}{\text{charge (Q)}}$$

$$\text{Unit of potential difference} = \frac{\text{Unit of work done}}{\text{Unit of charge}}$$

$$= \frac{\text{J}}{\text{C}}$$

This is known as volt (V).

It is named in honour of the scientist Alessandro Volta.

The commonly used torch cell is an example of a source of emf. Write down other sources of emf known to you.

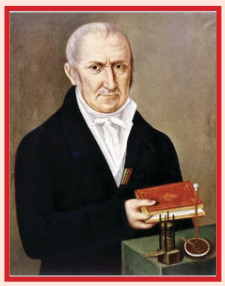
- Button cell
-

Write down the energy change that occurs in each of these in the science diary.

Source of emf	Energy change
• Torch Cell (Dry Cell)	Chemical energy into electrical energy
• Generator	Mechanical energy into electrical energy
• Button cell	
•	

Table 7.2

Alessandro Volta



Volta Battery

Place of Birth : Italy

Life time : 1745 - 1827

Domains of work : Physics, Chemistry

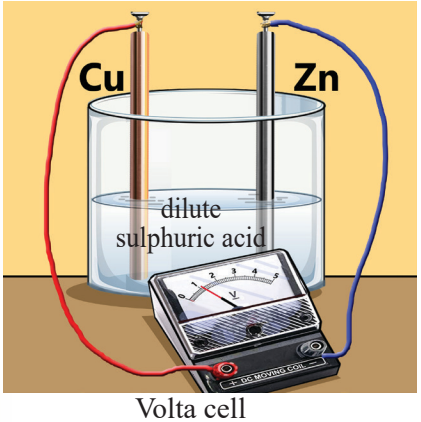
Major contributions : Discovered electro-chemical cell and methane. Voltage and volt (V, unit of potential difference) are associated with his name. Conducted studies on electric charge, potential difference and chemistry of gases. He was a teacher in the University of Pavia, Italy for a long time.

Alessandro Volta first designed a device that could be used as a source of emf. This is volta cell. Find more information about him and write down in the science diary.

Let's make a simple volta cell. Place a zinc rod and a copper rod in a beaker containing dilute sulphuric acid as the electrolyte [Fig.7.9]. Connect a voltmeter to the copper rod and the zinc rod.

- What do you observe?

The electrons are transferred due to the reaction of zinc with dilute sulphuric acid and flows through the external circuit. Hence the needle of the voltmeter deflects. Copper rod is at a high energy level of electric charges (positive potential) and zinc rod is at a low energy level of electric charges (negative potential). Therefore, current flows from the copper rod to the zinc rod in the external circuit.



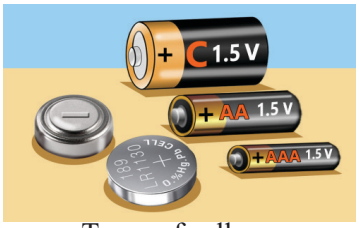
Volta cell
Fig. 7.9

Connect an LED instead of the voltmeter, and Mg instead of Zn in the above arrangement. What do you observe?

- What happens to the intensity of light if this cell is operated for a short interval of time?
- What may be the reason?

As the rate of chemical reaction decreases, the electric energy obtained also decreases. Primary cells are those which cannot be reused after using it for a certain period. Write examples for primary cells.

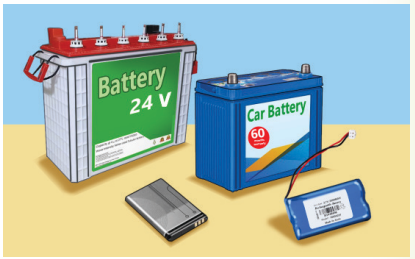
- Dry cell
-



Types of cells
Fig. 7.10

Secondary cells (also known as storage cells) are energy sources that can be recharged and reused. A battery is a system in which multiple cells are arranged and used as a single source of electricity. Write down more examples for secondary cells/batteries.

- Mobile battery
-



Different types of storage batteries
Fig 7.11

How is the potential difference between the terminals of a cell / battery measured? Voltmeter is a device for measuring potential difference. Observe the diagram (Fig.7.12) in which the potential difference is measured using the voltmeter.

We know that a cell has two terminals, positive (+) and negative (–). Voltmeter also has two terminals.

- Which terminal of the cell is connected to the positive terminal of the voltmeter?
- What about the negative terminal?

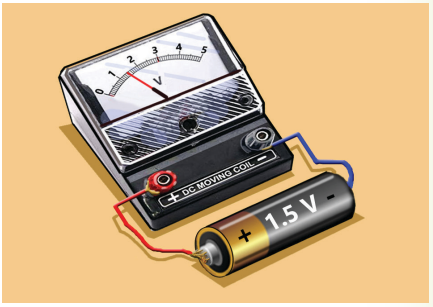


Fig. 7.12

Measure and tabulate the potential difference across the terminals of the following sources of electricity using a voltmeter.

Sources	Potential difference (V)
Torch Cell (Dry Cell)	
Button cell	
Volta cell	
Mobile battery	

Table 7.3

There are various types of electric sources from the early volta cell to today's solar panel. Gather information about them, prepare and present a seminar paper about their characteristics and where they are used.

Combination of Cells

Arrange two torch cells in three different ways as shown in the figure. Measure the potential difference across each of them using a voltmeter and tabulate them.

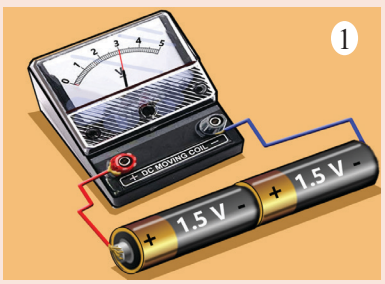


Fig. 7.13 (a)

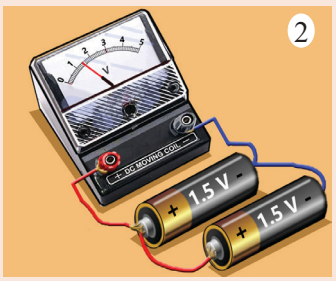


Fig. 7.13 (b)

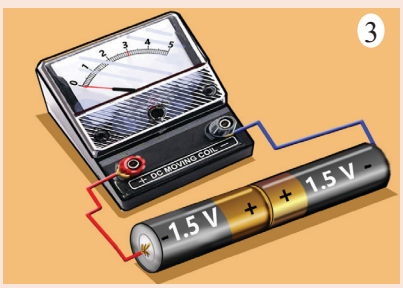


Fig. 7.13 (c)

Circuit	Number of cells	Voltmeter Reading / Potential Difference (V)
1	2	
2		
3		

Table 7.4

- In which arrangement was the maximum potential difference obtained?

The arrangement of cells as shown in figure 7.13 (a) is the series connection. Here, the positive terminal of one cell is connected to the negative terminal of the second cell. As the number of cells in series connection increases, the potential difference also increases.

When the cells are arranged in series, the total emf is equal to the sum of the emfs of the individual cells.

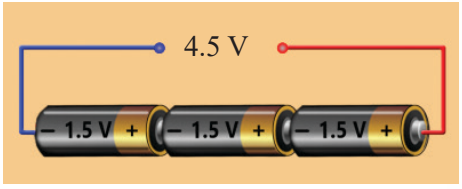
Write down in your science diary the instances where cells are connected in series.

- Remote control of TV
-

In the figure 7.13(b), cells are connected in parallel. In parallel connection the positive and negative terminals of one cell are connected to the positive and negative terminals of the next cell respectively. When identical cells are arranged in parallel, the effective potential difference of the combination is equal to that of a single cell. Cells are connected in this way to get electric current for a long interval of time. Cells are connected in parallel in power banks of mobile phones and the like.

Arrangement of cells in various gadgets
Fig. 7.14

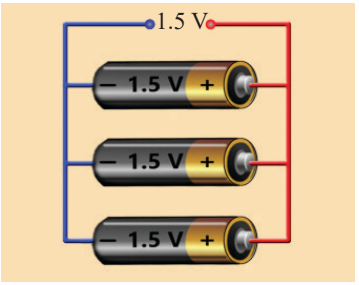
If the cells are arranged as shown in figure 7.13 (c), potential difference will not be obtained. So, the cells should not be arranged in this way.



Series method
Fig. 7.15

? Four cells with an emf of 1.5 V each are given. What is the maximum potential difference obtained using these? Illustrate the arrangement.

? If six identical cells are connected in series to form a battery of 9 V, what is the emf of one cell?



parallel method
Fig. 7.16

Safety measures to be adopted while using cells / batteries

- Do not connect the positive terminal and negative terminal of a battery directly using a conductor (short circuit).
- Do not put cell / battery in the mouth or chew it.
- Do not use the battery if it is overheated.
- Avoid situations where the battery comes in contact with water or fire.
- Metals such as nickel, cadmium and lead in various types of batteries are harmful and should be disposed carefully.

How do we calculate electric current in a circuit?

Intensity of Electric Current

Electric current is the flow of electric charges.

Intensity of electric current or current is the quantity of electric charge flowing through a conductor per unit time. The letter I is used to denote intensity of electric current.

Andre Marie Ampere

Place of Birth : France

Life Time : 1775 -1836

Domains of work : Physics, Mathematics, Philosophy and Astronomy. Lecturer at the University of Paris.

Major contributions :

Conducted many experiments related to electricity. He laid the foundation for electro magnetic theory, a pivotal branch of Physics.

If a charge Q flows through a circuit in a time t, calculate the charge that flows in one second?

$$\text{Charge flowing per second} = \frac{Q}{t}$$

$$I = \frac{Q}{t}$$

Let's find the unit of current from this equation.

$$\text{unit of current} = \frac{\text{unit of charge}}{\text{unit of time}}$$

$$= \text{.....}$$

The unit of current is given as C/s.

It is known as ampere (A).

The unit ampere is given to intensity of electric current in honour of the scientist, Andre Marie Ampere. Smaller units milli ampere (mA) and micro ampere (μA) are also used to measure current.

$$1\ A = 1000\ mA$$

$$1\ mA = 1000\ \mu A$$

? If 10 C charge flows through a conductor in 5 s, what is the current?

? If a current of 1.5 A flows through a conductor for 3 s, calculate the quantity of electric charge that passes through the conductor.

Electric Current through Conductor

There are many free electrons in a conductor. When a conductor is connected to a source of emf as shown in figure 7.17, the electrons at the end A of the conductor experience a force. At the same time, the electrons at the end B of the conductor will also experience the same force. Hence an equal number of electrons entering the conductor from the negative terminal of the source simultaneously return through the other end of the conductor and reach the positive terminal of the source. This is why devices operate immediately when the switch is turned on. Insulators contain a few number of free electrons.

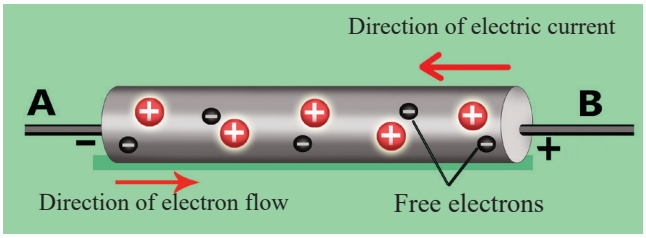


Fig. 7.17

When current flows through a conductor, electrons flow from the negative terminal to the positive terminal of the current source. However, the direction of electric current is considered to be from positive to negative.

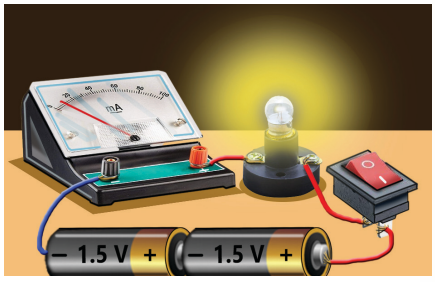


Fig. 7.18

It is impractical to find out the intensity of electric current in commonly used circuits using the quantity of charge and time by applying a mathematical equation. The current in a circuit is measured using the device called ammeter. Observe figure 7.18 and understand how to connect an ammeter in a circuit.

- If an ammeter connected in an electric circuit shows a reading of 1A, what is the charge flowing through the ammeter in one second?

Clamp Ammeter

It helps to measure the current through a circuit without being connected to the wire or device in the circuit. A clamp ammeter is used to measure high current associated with household electric circuits and the like. It works using the magnetic field induced by electric current.

Let's draw a circuit diagram

An electric circuit is an arrangement that connects a source of electricity with a device so that current can flow through it. A circuit diagram is drawn using the symbols of the components of the circuit.

Electricity in Living Beings

Electric signals are generated in the organs like brain and heart of our body. Instructions from the brain travel through the nerves as electric signals. The heart rate is maintained by the electric signals produced by the sinus nodes of the heart.

The electric eel is a marine fish capable of producing an electrical signal of about 600 volt. They use this to catch their prey.

- Observe the following circuit in figure 7.19 (a). Understand how the circuit diagram is drawn using symbols (figure 7.19 (b)).

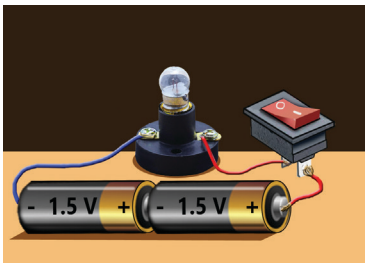


Fig. 7.19 (a)

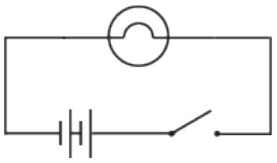


Fig. 7.19 (b)

- Draw a circuit using the table 7.5. Write down the names of any three components and their use.

Let's construct a torch

Construct a small torch using two torch cells, a suitable LED, wires, switch and PVC pipe.

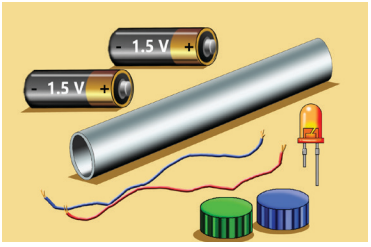


Fig. 7.20

? Observe the circuit in figure 7.21. Tabulate the symbols of the ammeter and voltmeter, their uses and how they are connected in the circuit.

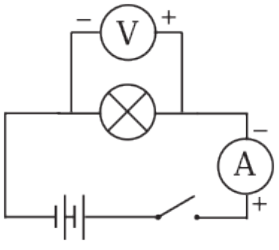


Fig. 7.21

Name and symbol of some components in electric circuits	
Component	**Symbol**
Cell	
Battery	
Switch/Key	
Switch/Key on	
Bulb/Lamp	
LED	
Voltmeter	V
Ammeter	A

Table 7.5

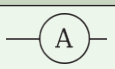
Voltmeter	Ammeter
	
To measure potential difference	
In parallel to the device	
	The positive terminal of the ammeter should be connected to the positive of the cell and the negative terminal to the negative of the cell.

Table 7.6

Haven't you understood what potential difference and current are, in an electric circuit?

Is there any relation between potential difference and current in a circuit?

Ohm's Law

Let's do an activity.

Construct a circuit using two torch cells, an ammeter, a resistor and a switch as shown in figure 7.22. Measure the potential difference and current through the circuit and tabulate. Repeat the activity by increasing the number of cells in series.

Number of Cells	Voltage (V) V	Current (I) A	$\frac{V}{I}$
2	3		
3			
4			

Table 7.7

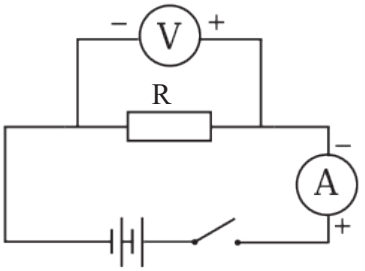


Fig. 7.22

- What change in voltmeter reading (potential difference) is observed when the number of cells increases?
- What change in potential difference is observed when the current (ammeter reading) increases?
- Isn't the value of $\frac{V}{I}$ approximately equal?

It is understood that as the current increases the potential difference also increases and $\frac{V}{I}$ is a constant.

That is, $I \propto V$ or $V \propto I$

$V =$ a constant $\times I$

$\therefore \frac{V}{I} =$ a constant

This constant will be equal to the resistance in the circuit.

It is denoted by the letter R.

$$R = \frac{V}{I}$$

Georg Simon Ohm

Country of Birth : Old Rome (present Germany)
Life time : 1789-1854
Domains of work : Physics
Major Contributions : Conducted many experiments related to electricity. An important law was formulated regarding the relationship between potential difference and current. Lecturer at Erlangen University. The unit of resistance, ohm is named in his honour. The Greek alphabet Omega (Ω) is the symbol of ohm.

Resistance is the property of a conductor to oppose the flow of current through it.

The relation between potential difference and current in a circuit was formulated by the scientist Georg Simon Ohm. He realised that the resistance in a circuit varies as the temperature varies.

Ohm's law states that, the current through a conductor is directly proportional to the potential difference across the conductor when the temperature is constant.

- What will be the unit of resistance?

$$R = \frac{V}{I}$$

$$\text{Unit of resistance} = \frac{\text{unit of potential difference}}{\text{unit of current}}$$

$$= \frac{\text{----------}}{\text{----------}}$$

$$= \text{----------}$$

The unit of resistance volt / ampere is known as ohm (Ω).

Larger units such as kilo ohm (kΩ) and mega ohm (MΩ) are also used.

$1\ k\Omega = 1000\ \Omega\ (10^3\ \Omega)$

$1\ M\Omega = 1000\ k\Omega\ (10^6\ \Omega)$

When current flows through a conductor, resistance is caused by the collisions between free electrons and atoms in the conductor.

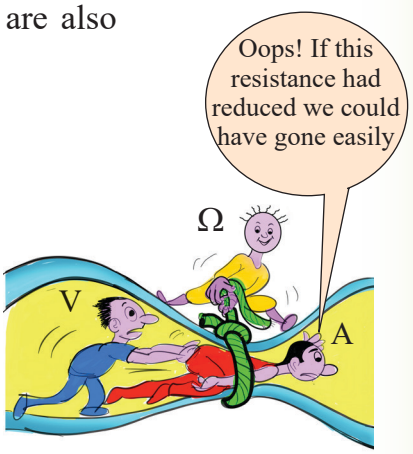


Fig. 7.23

? What happens to the current through the circuit when the resistance increases?

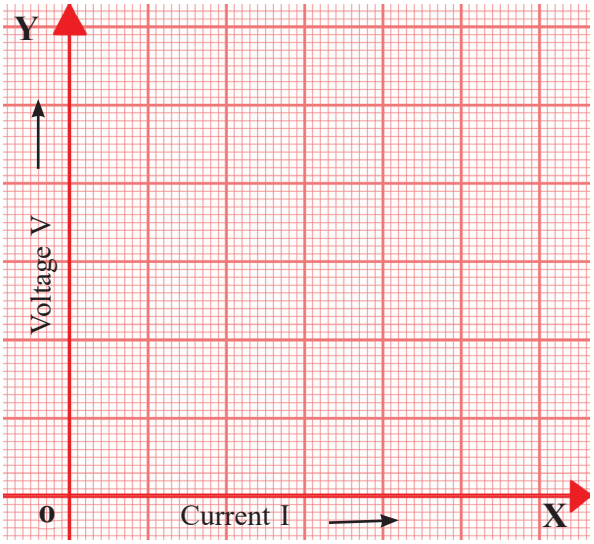
increases / decreases

? What is the SI unit of resistance?

? Complete table 7.8 based on Ohm's law and draw a graph. Plot a graph by taking current on the X-axis and voltage on the Y-axis. What is the peculiarity of the graph obtained?

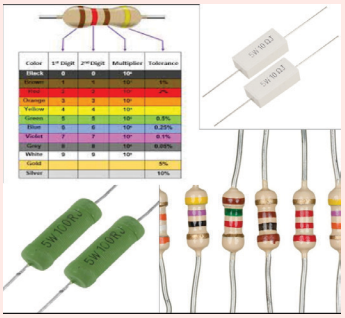
V	I	R
9 V	1 A	
3 V		6 Ω
	2 A	3 Ω

Table 7.8



Graph 7.1

Resistors



Resistors of various values are available in the market. Different types of resistors are used in various electronic devices. Their values may be marked on the resistor or indicated by colour codes.

Resistor

Conductors used to introduce a certain resistance in a circuit are called resistors. Its symbol is —/\/\/\— or —▭—.

Multimeter is a device used to measure the resistance of conductors directly. Potential difference, current etc., can also be measured using it.

What are the factors that influence resistance?

Measure the resistance of the nichrome wire used in the electric heater with a multimeter immediately after the heater is turned off. Measure again after it cools.

- In which case is resistance higher?

Haven't you understood that resistance decreases with decrease in temperature?

- Do any other factors influence resistance?

Arrange a circuit as shown in figure 7.25.

CD is a nichrome wire of 40 cm long.

Multimeter

Fig. 7.24

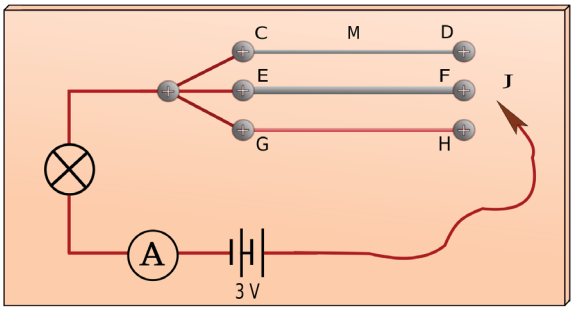


Fig. 7.25

EF is a nichrome wire having the same length and twice the thickness of CD.

GH is a copper wire of the same length and diameter as CD. They are screwed on a wooden board.

M is the midpoint of the nichrome wire CD.

J is the free end of the conductor whose other end is connected to the negative terminal of the battery as shown in figure 7.25. Touch the free end J to M, D, F and H one after the other. Observe the changes in the intensity of light of the bulb and the ammeter reading.

Tabulate the observations. Write answers to the questions based on observations and analysis of the table.

The point where the end J touches	Length / thickness of the conductor	Material of the conductor	Ammeter reading
M	20 cm	nichrome	
D	40 cm	nichrome	
F	40 cm (thicker)	nichrome	
H	40 cm	copper	

Table 7.9

In all cases, the potential difference applied across the circuit is the same. According to Ohm's law, V = IR. Isn't the change in the ammeter reading attributed to the change in the resistance of the conductor?

- In which situation is the ammeter reading (current) the least?
- What is the reason?

  more resistance / less resistance
- What happens to the resistance as the length of the same conductor increases?
- What happens to the resistance as the thickness of the same conductor increases?
- Which has more resistance, nichrome or copper having the same length and thickness?

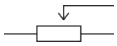
Superconductivity

It was discovered in 1911 that some metals and compounds exhibit no electric resistance at very low temperature. Such materials are superconductors. Electricity can flow through superconductors without loss of energy.

Based on these activities, write down the factors that influence the resistance of a conductor.

- The nature of the material of the conductor
- The thickness (area of cross section) of the conductor.
-

It is now understood that the resistance of a conductor increases as length increases and decreases as the area of cross section increases. Different substances also have different resistances. Consider wires of nichrome, tungsten, copper, aluminium and silver of the same length and thickness. Among these, nichrome and tungsten have relatively high resistance while aluminium and copper have very low resistance. Silver has the least resistance.

As the length of a conductor increases without any change in its area of cross section, its resistance also increases. A rheostat is a device that works on this principle. While doing electric experiments in school labs, a rheostat is connected to a circuit to vary the current as needed. The symbol of a rheostat is  or  .

Construct a circuit connecting a rheostat as shown in figure 7.26. Move the sliding contact S of the rheostat steadily and observe the change in the intensity of light of the bulb.

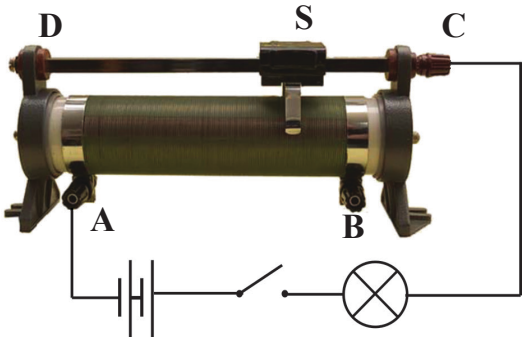


Fig. 7.26

- What is the working principle of a rheostat?

Working of a Rheostat

Observe figure 7.27.

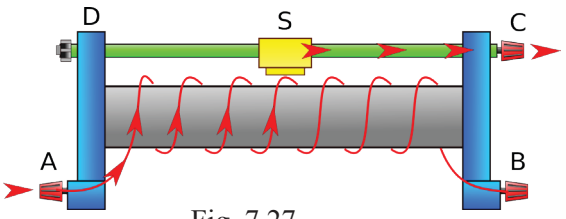


Fig. 7.27

AB – A high resistance wire wound around a pipe which is an insulator.

DC – Metal rod having very low resistance.

S – Sliding contact

Current flowing from A passes through the coil and reaches the end C through S. As the sliding contact S is moved from D to C of the metal rod, the length of the coil through which the current passes varies. As a result, the resistance in the circuit and hence the current can be changed as and when required.

A rheostat has 100 turns of resistance wire. The resistance of one turn is 0.15 Ω. Then which of the following values of resistance cannot be included in a circuit using this rheostat? Justify your answer.

a) 3 Ω b) 7.5 Ω c) 4 Ω d) 8.25 Ω

How can we incorporate different values of resistance in to the circuit using fixed value resistors?

Arrangement of Resistors in Circuits

Construct two circuits as shown in figure 7.28 (a), 7.28 (b) using a 3 V battery, switches and 3 V bulbs. Turn on both the switches and observe light from both bulbs.

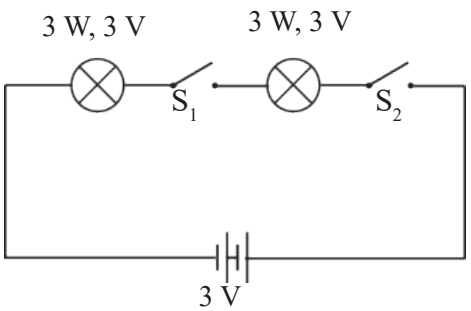


Fig. 7.28 (a)

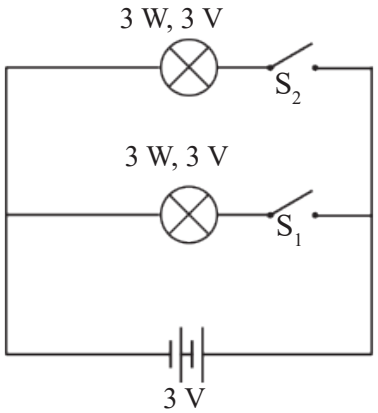


Fig. 7.28 (b)

PhET→ Circuit Construction Kit→ Virtual Lab

- Turn on S_1 and S_2 in both circuits. In which circuit does the bulb glow more brightly?
- Turn on only the switch S_1 in both circuits. What is your observation?
- Why do the bulbs in figure 7.28 (b) glow relatively brighter if all the switches in both circuits are turned on?

The difference in potential difference and current are the reasons for the increase or decrease in the intensity of light. The arrangement of the bulbs as shown in figure 7.28 (a) is the connection in series. The arrangement of the bulbs as shown in figure 7.28 (b) is the connection in parallel. Does the resistance in the circuit differ when connected in series or parallel? More characteristics of series and parallel connections can be understood by using circuits with resistors instead of bulbs.

How do we find the effective resistance in a circuit?

Effective Resistance

When two or more resistors are included in a circuit, the effective resistance is equivalent to the resistance of a single resistor that can provide the same effect as that of the combined effect of individual resistors.

Series Connection

Observe the circuit in figure 7.29.

When resistors are connected in series, the potential difference is divided between the resistors.

That is, $V = V_1 + V_2$

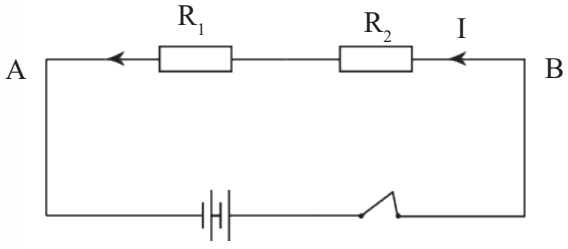


Fig. 7.29

According to Ohm's law $V = I \times R$ (R is the effective resistance in the circuit and V is the potential difference between terminals A and B).

Since the current (I) flowing through both the resistors is equal,

$$V_1 = I \times R_1 \, , \, V_2 = I \times R_2$$

That is, $I \times R = I \times R_1 + I \times R_2$

$$IR = I (R_1 + R_2)$$

$$R = R_1 + R_2$$

Haven't you understood that when resistors are connected in series, the effective resistance of the circuit increases? When resistors are connected in series, the effective resistance is the sum of the resistances of all resistors.

If n resistors of resistance R Ω each are connected in series, the effective resistance will be nR.

- When resistors are connected in series, what will be the potential difference between the ends of the resistor with higher resistance?

  more / less.

- If resistors of the same value are connected in series, what will be the potential difference across the ends of the resistors?

  equal / different

? **8 Ω, 4 Ω resistors and a 6 V battery are provided.**

a) Draw a circuit diagram in which these resistances are connected in series.

b) Find the effective resistance in the circuit.

c) Calculate the current in the circuit.

? **When ten resistors of 2 Ω each are connected in series, what is the effective resistance?**

? **How many resistors of resistance 6 Ω each should be connected in series to get an effective resistance of 42 Ω?**

Parallel Connection

If the resistors are connected in parallel, as shown in figure 7.30, the current is divided through each branch.

Then the total current in the circuit is equal to the sum of the currents through the branches.

$$I = I_1 + I_2$$

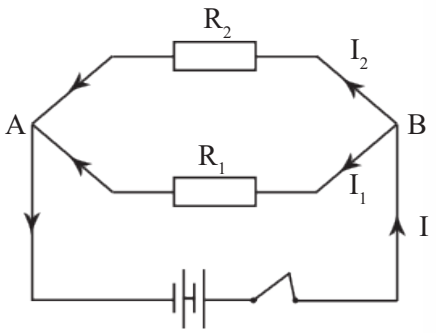


Fig. 7.30

If R is the effective resistance in the circuit and V is the potential difference across the terminals A and B, then according to Ohm's law,

$$I = \frac{V}{R}$$

Since the potential difference across the two resistors is equal,

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2}$$

$$V\left(\frac{1}{R}\right) = V\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R = \frac{R_1 R_2}{R_1 + R_2}$$

Fig. 7.31

Now we have understood that when resistors are connected in parallel, the effective resistance of the circuit decreases.

If n resistors of R Ω each are connected in parallel, the effective resistance will be $\frac{R}{n}$.

? Resistors 6 Ω, 3 Ω and a 6 V battery are given.

a) Draw the circuit diagram connecting them in parallel.

b) Find the effective resistance of the circuit.

c) Calculate the current through each resistor.

? If resistors of the same value are connected in parallel, what will be the current through each resistor?

? What is the effective resistance when five 10 Ω resistors are connected in parallel?

? Find the effective resistance of the arrangement given in figure 7.32.

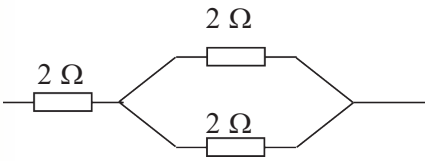


Fig. 7.32

Write down in the science diary the differences between series combination and parallel combination of resistors.

You have now understood that resistors reduce the current through a circuit. Usually combination of resistors of suitable values are connected in circuits to reduce the potential difference or current in accordance with our requirement.

Electric devices such as bulbs, heaters, and electric iron used in a circuit have resistors.

- How are electric appliances such as bulbs, fans etc., connected in household circuits?
- What are the advantages of connecting electric appliances in parallel?

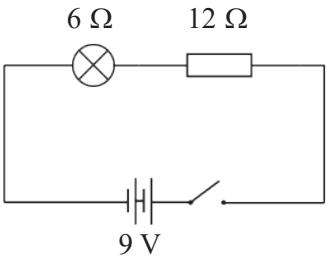


Fig. 7.33 (a)

A circuit consisting of a 3 V bulb, a 12 Ω resistor and a 9 V battery is given in figure 7.33 (a). Another circuit without the 12 Ω resistor is given in figure 7.33 (b). The resistance of the bulb is 6 Ω. Analyse the circuit and find answers to the following questions.

- Which circuit has more resistance?
- In which circuit, is a potential difference of 3 V obtained between the ends of the bulb?
- What happens to the bulb in the circuit 7.33 (b) when it is switched on?

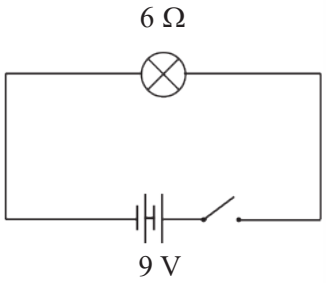


Fig. 7.33 (b)

As the bulb receives more potential difference and current than required, the bulb gets damaged.

Now isn't it clear that the component connected to the LED in the circuit exhibited at the school science fair is a resistor and why it is connected?

- Is there any difference between the electricity we obtain from battery / cell and the electricity we get in our houses?

The electricity from the battery flows only in one direction (Direct Current). But the electricity in our houses changes direction at regular intervals of time (Alternating Current) and is of high voltage (230 V). **Hence, do not connect the circuits to household electricity while doing the experiments that you have done in the class.** Discuss with elders the precautions to be taken while using electricity.

Let's Assess

1) Which of the following device converts chemical energy into electric energy?

a) Dry cell b) Dynamo c) Solar cell

2) For current to flow from a cell in a closed circuit, the two terminals of the cell must be

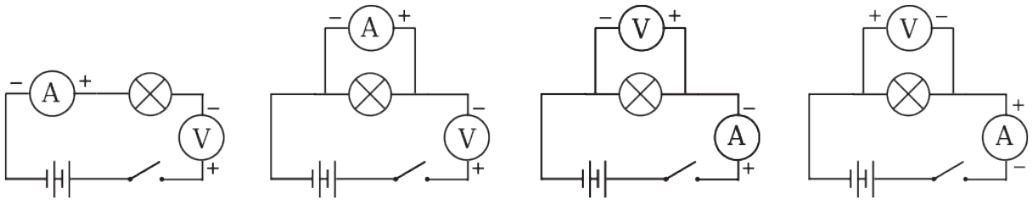
a) at high potential.

b) having a potential difference between them

c) at different temperatures

d) at different heights.

3) In which of the following circuits are the ammeter and the voltmeter connected properly?



(a) (b) (c) (d)

Fig. 7.34

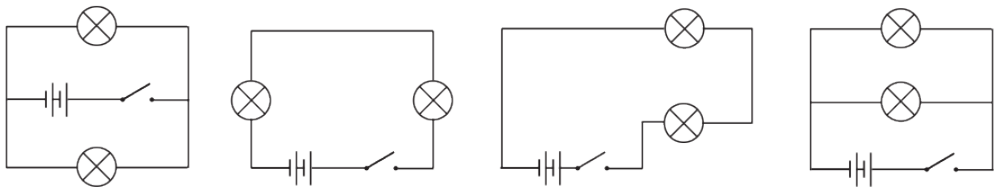
4) Match the terms in column A with those in columns B and C.

A	B	C
Potential difference (V)	Q/t	ohm (Ω)
Current (I)	W/Q	volt (V)
Resistance (R)	V/I	ampere (A)

Table 7.10

5) 50 J of work is done to move an electric charge of 5 C from point M to N in an electric circuit. What is the potential difference between M and N?

6) In which of the following circuits are bulbs connected in series?



(a) (b) (c) (d)

Fig. 7.35

7) Analyse the circuit given below and answer the following questions.

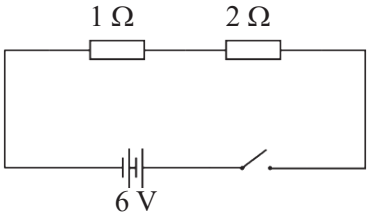


Fig. 7.36

a) Calculate the effective resistance in the circuit when the switch is turned on.

b) What is the current through the circuit?

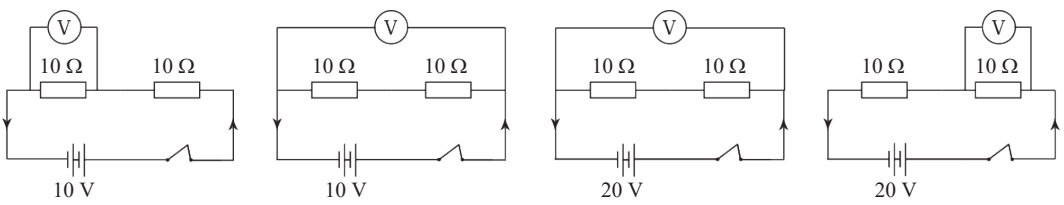
c) What is the potential difference across the 2 Ω resistor?

d) What is the current flowing through the 1 Ω resistor?

8) In an electric circuit, in which way are the fan and its regulator connected?

parallel / series

9) Consider the following circuits. Which voltmeter shows a reading of 10 V?



(a) (b) (c) (d)

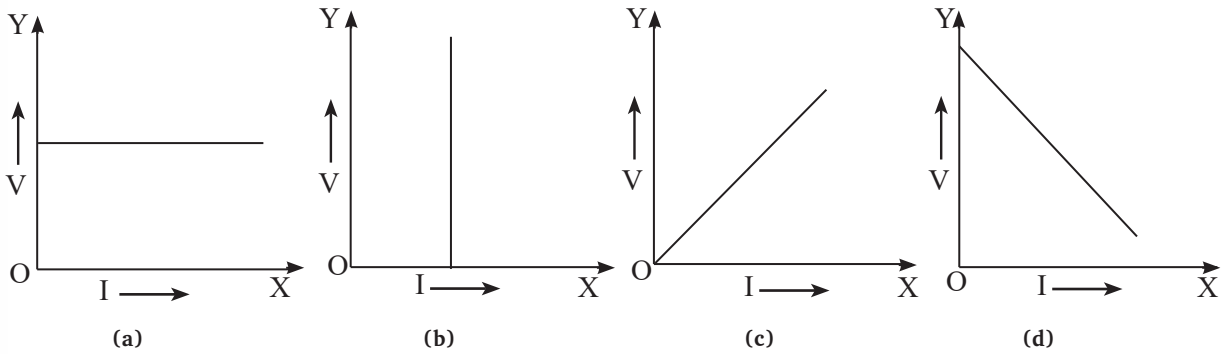
Fig. 7.37

10) A wire of length 50 cm has a resistance of 5 Ω. If the length is doubled by stretching,

a) what happens to the area of cross section (thickness) of the conductor?

b)What will be the resistance of the wire?

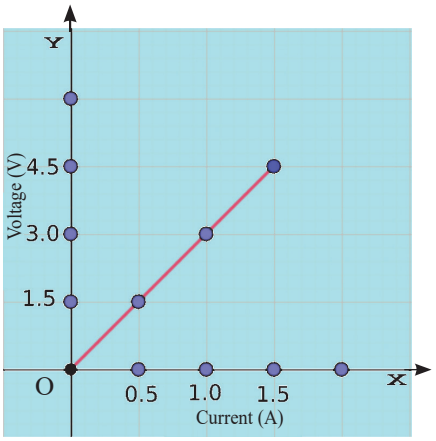
11) Which of the graphs given below represents Ohm's law?



Graph 7.2

Extended Activities

1) The graph given below represents Ohm's law. Analyse the graph and find the resistance.

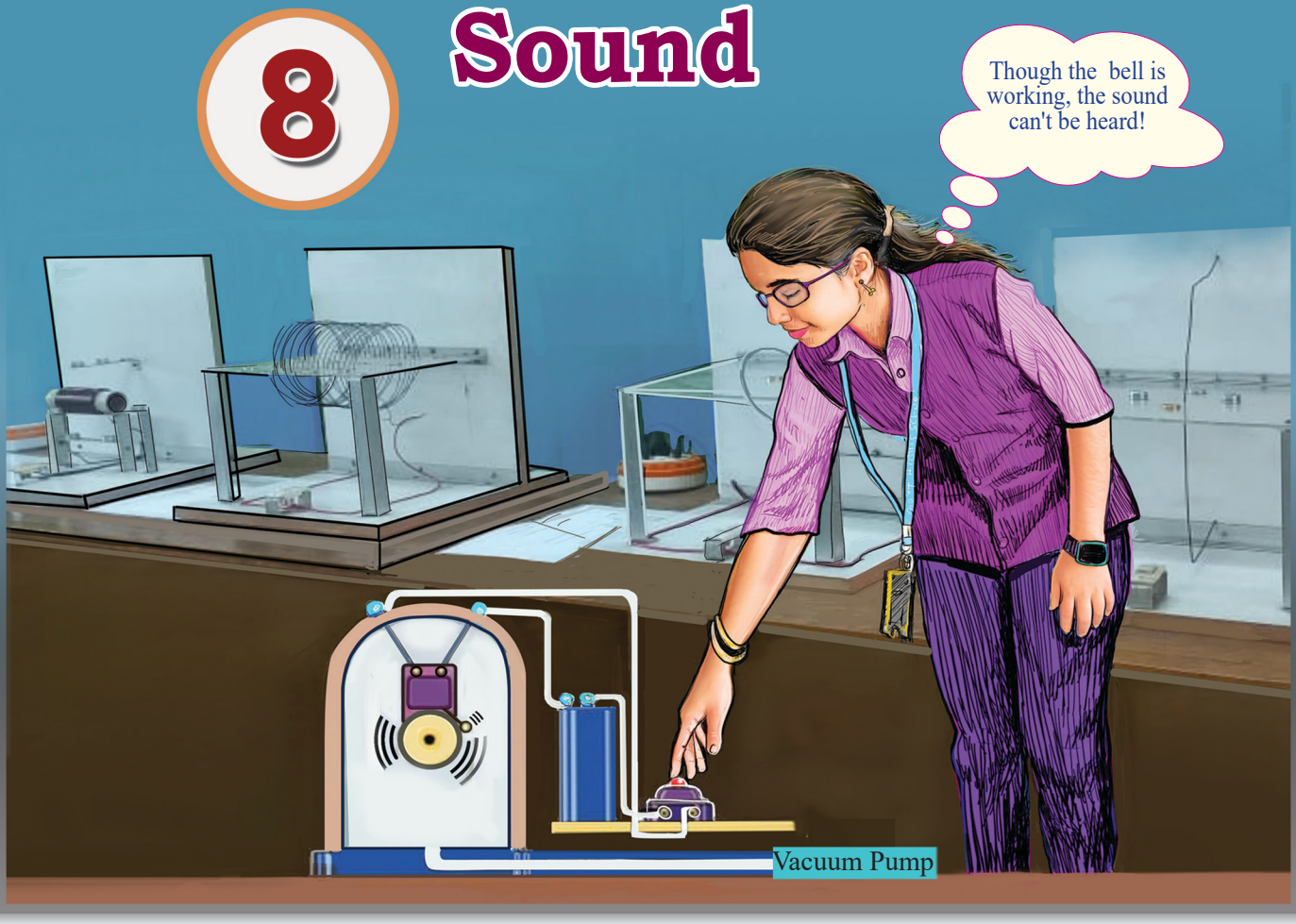


Graph 7.3

2) Draw a circuit diagram connecting three LEDs of 3 V and a 9 V battery. Construct the circuit and light the LEDs.

3) Measure the emf across the terminals of a dead torch cell and a new torch cell using a multimeter. Do you get any difference in their value? What is the reason?

8 Sound



The child cannot hear the sound even though the alarm inside the bell jar is ringing! What is the reason? Haven't you also had such doubts?

We hear many natural and man-made sounds. Can you imagine a world without sound? What is sound?

- What are the sounds familiar to you? Write them down.
  - The ringing sound of the school bell
  - The song of Cuckoos
  - The rolling sound of thunder
  -

Sound is the form of energy that gives the sense of hearing.

- List the situations where sound is useful in daily life.
  - To enjoy music
  -

Fig. 8.1

What may be the reason for the sound from this bell?

How is sound produced?

Let's do an activity.

Make a device that can produce sound using a pencil box, rubber band and pencils as shown in figure 8.2.

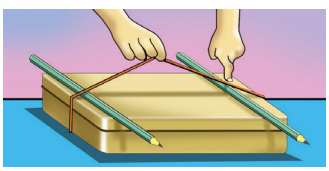


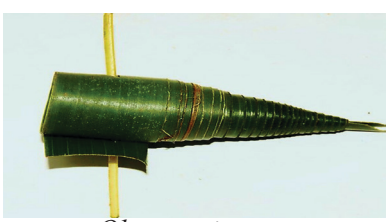
Fig. 8.2

Pull the middle of the rubber band and release.

- Do you hear the sound?
- Do you feel the rubber band move back and forth rapidly?
- What kind of motion is the rubber band in?

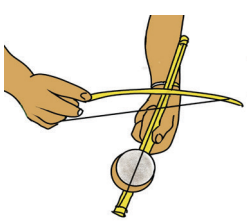
  (vibration / linear motion)

You are familiar with toys that make sound. Which are they? Write them down.



Olapeeppi
Fig. 8.3 (a)

Paper whistle
Fig. 8.3 (b)



Chiratta veena
Fig. 8.3 (c)

- Make your favourite toy and listen to its sound. Discuss how it produces sound and write in your science diary.

Let's try another activity.

Excite one prong of a tuning fork by striking it with a rubber hammer. Bring the excited tuning fork close to the ear.

Fig. 8.4

- Can you hear the sound?

Gently touch the prongs of the tuning fork.

- Don't you feel the vibration in the prongs of the tuning fork?

Excite the tuning fork and touch the prongs gently on the surface of the water in the bowl as shown in figure 8.5.

Fig. 8.5

- Doesn't the vibration of the tuning fork cause the splashing of water?

Excite the tuning fork again and hold both its prongs firmly with your hands.

- Can you hear the sound?
- Is the tuning fork vibrating now?
- What is the inference drawn from the observations?

> Sound is produced by the vibration of objects.

Sound sources are objects that produce sound.

Write down examples of sound sources.

- Tuning fork
- Musical instruments
-

Have you ever noticed the parts that vibrate while playing musical instruments?

List the names of the musical instruments you are familiar with, in the science diary.

- Flute
- Mridangam
-

Fig. 8.6

- Which are the vibrating parts of the musical instruments you have listed?

Confirm your inferences by visiting the music room in your school or discussing with experts.

Complete table 8.1 by writing the results of your observation.

Musical Instrument	The main part that vibrates and produces sound	Associated vibrating parts
Veena	Strings	----------
Violin	----------	----------
Ilathalam	----------	----------
Tabla	----------	----------
Harmonium	Reeds	----------
Chenda	----------	The wooden frame, the air column inside the chenda

Table 8.1

Every source of sound has a main part that vibrates.

The sound we hear from a source of sound is the result of the vibrations of various parts of the source and the vibrations of the surrounding air.

The vibrations of the main part and the associated parts help to make the sound from the musical instruments more pleasant and intense.

Which part vibrates mainly when I speak?

Touch your throat while speaking loudly. Don't you feel the vibration?

Sound is produced when the vocal cords in the upper part of the larynx vibrate.

- Are the vocal cords the only part that vibrates when we speak?

List the associated parts that are likely to vibrate.

- The muscles
-

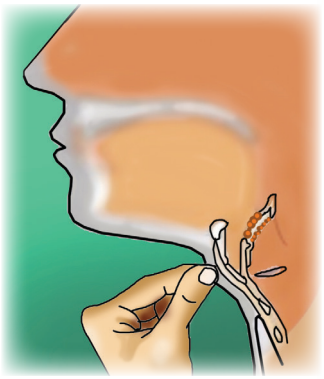


Fig. 8.7

Which is the main part that vibrates when the following musical instruments are played?

(a) Mridangam (b) Flute (c) Guitar

List the names of musical instruments in which the air column vibrates as the main or associated part.

Which body part of the organisms listed in table 8.2 mainly vibrate when they make sound? Complete the list by gathering information.

Creature	Part that vibrates to produce sound
Honey bee	The wings
Elephant	The vocal cords
Mosquito	
Cicada (*cheeveedu*)	
Cuckoo	

Table 8.2

How does sound coming from different sound sources reach our ears?

Propagation of Sound

Try an activity.

Fig. 8.8

Hang a battery operated buzzer inside a transparent glass container. Attach a plastic tube as shown in the figure and close the container.

- Can you hear the sound?

Draw the air inside the container into the mouth through the tube attached to the container.

- Do you sense the sound diminishing?
- Try removing some more air. Doesn't the sound decrease again?
- Could you have heard the sound if the air had been completely removed?
- What can be inferred from this experiment?

Write it down in the science diary.

Sound travels through air and reaches our ears. Sound cannot travel through vacuum.

Take a look at the picture at the beginning of the lesson. Now it is understood why the sound of the alarm inside the bell jar could not be heard outside the jar, when the air inside is evacuated with a vacuum pump.

Does sound travel only through air?

Fig. 8.9

Let's do two more activities in connection with the propagation of sound.

Let the children place their ears on the desk. Ask another child to excite the tuning fork and press firmly its stem on the desk.

- Can you hear the sound?
- In this situation, which are the mediums through which sound is transmitted?

- Can sound travel through solids?

Record the inference in science diary.

PhET→ Sound Waves

Sound can also travel through solids.

If so, can sound travel through liquids?

Take water in a bucket. Immerse a steel bowl in the water and tap it with a spoon. Can you hear the sound?

Fig. 8.10

- Through which mediums did sound travel in this case?
- What is the inference from this activity?

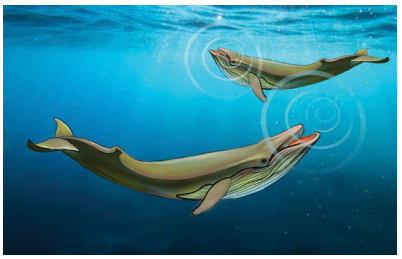
  Write it down in the science diary.

Sound can travel not only through gases but also through liquids and solids.

Sound needs a medium for its propagation.

Snake - utilises sound transmission through the floor for catching prey and self-defence.

Fig. 8.11 (a)



Aquatic animals such as dolphins and whales communicate by sound transmission through sea water.

Fig. 8.11 (b)

Why do astronauts use a radio system to talk to each other?

Fig. 8.12

Thunder and lightning occur at the same time. But the sound of thunder is heard only after seeing the flash of lightning. Why is it so?

Speed of Sound

Analyse table 8.3 and answer the questions.

State of matter	Medium	Speed of sound(m/s) 25°C
Solid	Aluminium	6423
	Steel	5944
Liquid	Sea water	1525
	Pure water	1485
Gas	Helium	968
	Air	347

Table 8.3

- Does sound travel at the same speed through all mediums?
- In which state of matter is the speed of sound greater? In which is it lesser?

Haven't you understood that the speed of sound is different in different mediums? When the temperature of the medium changes, the speed of sound through it also changes. As the temperature increases, the speed of sound increases.

? At night, the sound from a firecracker is heard 3 s after seeing the flash of light. How far did the explosion take place? (Consider the speed of sound as 350 m/s).

The speed of light in air (3×10^8 m/s) is very high. But the speed of sound in air is only 350 m/s. So at the time when the firecracker bursts, its light is seen instantly by a person standing far away.

Distance travelled by sound = speed of sound × time

= 350 m/s × 3 s = 1050 m

? In many cases thunder is heard only a short time after the flash of lightning is seen. Explain the reason.

Can we hear sound, if there is only a sound source and a medium?

Ear and Hear

How do we hear sound? Which sense organ helps us for this?

Let's do an activity.

Fasten a piece of burst balloon as diaphragm to any one end of a plastic bottle with both ends cut off. Fix a rim of transparent material of about 2 cm height vertically above the diaphragm. Put some mustard seeds on the diaphragm.

Speak loudly through the open part of the bottle as shown in figure 8.14, so that sound falls on the diaphragm. Observe the mustard seeds.

Fig. 8.13

Don't you see the mustard seeds moving up and down? Wasn't the movement of the mustard seeds due to the vibration of the diaphragm?

Fig. 8.14

The ear has a part called the tympanum (eardrum) which can vibrate like the above diaphragm (Fig. 8.15).

A vibrating object causes rapid pressure variations in the air around it. These pressure variations are transmitted through the medium and cause the eardrum to vibrate. The eardrum propagates these vibrations to the inner ear. We experience sound when these vibrations or signals reach the brain.

To sense the sound, we need three components namely the sound source, medium and the sense organ for hearing.

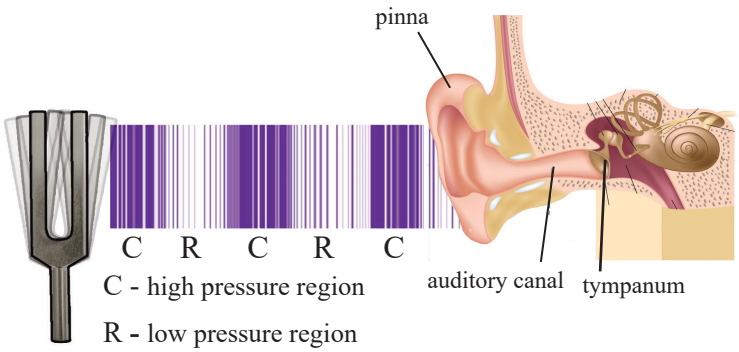


Fig. 8.15

Fig. 8.16

Have you ever thought about the world of the hearing impaired?

Have you noticed the poster of the World Hearing Day observed on 3rd March?

Hearing loss may occur at birth or later. Such people have to endure suffering due to their hearing loss. Discuss the challenges faced by them and write it in your science diary.

- A barrier to communication
- Prone to accidents
-

- What should be the approach to the hearing impaired? Discuss based on the indicators.
  - Be empathetic.
  - Give consideration and include them in all activities.
  -

Based on this, prepare a short note to present on World Hearing Day.

Beethoven gifted the world the most melodious music. Helen Keller proved that it is possible to achieve great success in life with self-confidence, determination and hard work without flinching in adverse life situations. Many such great people have overcome hearing disorders and outshone in life.

Hearing loss can be detected through hearing tests using an audiometer.

A hearing aid is an electronic device that helps individuals with hearing loss to hear more clearly (Fig.8.17).

Helen Keller

Helen Keller was born on June 27, 1880 in TuxCumbia, Alabama, USA. She was a girl who was suddenly thrown from a world of sights and sounds into a world of darkness and silence.

Despite losing her eyesight and hearing at the age of 19 months, she proved herself in the fields of literature, social work and teaching through hard work and self-confidence.

Helen Keller is known as a genius who has become a beacon of survival for the entire human race. 'The Story of My Life' is Helen Keller's autobiography.

Hearing Aid
Fig. 8.17

- Conduct an interview with an audiologist about the hearing test and share the information with your classmates.

Protection of Ear

Putting any kind of object inside the ear is dangerous. It may rupture the eardrum and cause hearing loss. If any injury occurs, the complex structure of the ear makes the healing of the wound difficult, leading to infection and hearing loss.

- Find out the key aspects related to ear care that we should pay attention to and present them in the class.

Why is the noise at the traffic point annoying?

Fig. 8.18 (a)

Music and Noise

Compare the pleasing music you hear in music class with the noise at the traffic point. Which sound is pleasant to hear?

You can listen to enchanting music from *Chirattaveena*.

Then listen to the sound of a coconut shell (*chiratta*) being rubbed against a stone.

Compare the sound in both cases.

Fig. 8.18 (b)

A sound that has regular vibrations and is pleasant to hear is music. A sound that has irregular vibrations and is unpleasant is noise.

Have there been times when even music felt like noise? Doesn't loud sound beyond a certain limit seem to be annoying?

Doesn't loud noise hurt the ears?

Fig. 8.19

Noise Pollution

Have you observed the collage?

'Noise pollution is a serious menace to public health'

- What is your response to this statement?
- What do you mean by noise pollution?

Noise pollution is the production of unpleasant, disturbing and unwanted noise that harms human beings and other organisms.

What can be the causes of noise pollution?

- Increasing number of vehicles
- Public address systems
-

Fig. 8.20

Noise affects not only our physical health but also our mental and emotional health. Find out more about this from health care professionals and record them in the science diary.

- Which professional groups are most affected by noise pollution?
- Shouldn't noise pollution be controlled?
- What can we do to reduce noise pollution?

Noise pollution can be reduced

Fig. 8.21

Below are some steps to reduce the effects of noise pollution.

- Those who work in the construction sector, mines etc., should use ear muffs to protect their ears (Fig.8.20).
- Use hearing protection devices such as earplugs in areas where high-powered machinery and equipment are operated (Fig.8.21).

- Don't use air horns in vehicles.
- Ensure that silencers in vehicles are working efficiently.
- Use box type instead of horn type loud speakers.
- Plant more trees to reduce noise pollution.
- Don't use loudspeakers in public places before 6 am and after 10 pm.
- Avoid loud noise near hospitals, schools, courts etc.

Haven't you realised the need for eco-friendly sound system?

Pleasing sound is one of the best gifts that nature has given us. It enriches our leisure times.

Resul Pookkutty is a unique talent who won the prestigious Oscar Award for India, the world class honour in the film industry, for best sound mixing.

Many practical possibilities of the science of sound have been utilised in everyday life. You can learn more about them in higher classes.

Resul Pookutty

Resul Pookkutty was born in 1971 at Vilakkupara in Anchal, Kollam, Kerala. As a sound engineer, he won the Oscar for sound mixing in the Indian-set British film Slumdog Millionaire. Resul Pookkutty also won many national and international awards like Padma Shri Award, the BAFTA award in Britain and Cinema Audio Society Award in America. Rocheston Accredition Institute, New York bestowed him with the 'Distinguished Engineer' title for his valuable contributions in sound mixing. He is the first Asian to be a member of the Academy of Motion Pictures and Science Award Committee for Sound Mixing.

Let's Assess

1) Which part of the following sound sources vibrates prominently when sound is produced?

   a) Drums b) Madhalam c) Bugle

2) A source of sound is an essential component for hearing sound. Which are the other two components?

3) Plan an activity to demonstrate that sound travels through solids.

4) Write down whether the following statements are true or false. Correct them if wrong.

   a) Sound can travel through vacuum.

   b) Sound is produced by the vibration of objects.

   c) The speed of sound in solids is greater than that in gases.

   d) Speed of sound decreases as temperature increases.

5) Which of the given musical instruments produce sound by the vibration of the leather diaphragm.

   (violin, chenda, flute, mridangam, veena, tabla)

6) Can the astronauts directly hear each other while talking on the lunar surface? Why?

7) Write down an example each for music and noise.

8) Suggest two ways to reduce noise pollution.

9) Which of the following medium has the highest speed of sound? Which has the lowest ?

   a) solid b) gas c) vacuum d) liquid.

10) Describe the bell jar experiment to prove that sound requires a medium for propagation.

Extended Activities

1) If you have learned instrumental music, play the instrument in the class and explain how it works.

2) Make different types of toys that produce sound and organise a demonstration in the class.

3) Make toy telephones using paper cups and strings and operate them.

4) Prepare posters to make people aware of the dangers of noise pollution.

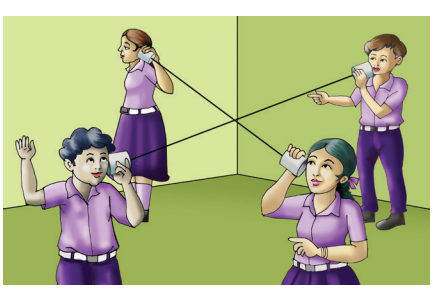


Fig. 8.22

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CONSTITUTION OF INDIA

Part IV A

FUNDAMENTAL DUTIES OF CITIZENS

ARTICLE 51 A

Fundamental Duties- It shall be the duty of every citizen of India:

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievements;

(k) who is a parent or guardian to provide opportunities for education to his child or, as the case may be, ward between the age of six and fourteen years.

CHILDREN'S RIGHTS

Dear Children,

Wouldn't you like to know about your rights? Awareness about your rights will inspire and motivate you to ensure your protection and participation, thereby making social justice a reality. You may know that a commission for child rights is functioning in our state called the ***Kerala State Commission for Protection of Child Rights.***

Let's see what your rights are:

- Right to freedom of speech and expression.
- Right to life and liberty.
- Right to maximum survival and development.
- Right to be respected and accepted regardless of caste, creed and colour.
- Right to protection and care against physical, mental and sexual abuse.
- Right to participation.
- Protection from child labour and hazardous work.
- Protection against child marriage.
- Right to know one's culture and live accordingly.
- Protection against neglect.
- Right to free and compulsory education.
- Right to learn, rest and leisure.
- Right to parental and societal care, and protection.

Major Responsibilities

- Protect school and public facilities.
- Observe punctuality in learning and activities of the school.
- Accept and respect school authorities, teachers, parents and fellow students.
- Readiness to accept and respect others regardless of caste, creed or colour.

Contact Address:

Kerala State Commission for Protection of Child Rights

'Sree Ganesh', T. C. 14/2036, Vanross Junction

Kerala University P. O., Thiruvananthapuram - 34, Phone : 0471 - 2326603

Email: childrights.cpcr@kerala.gov.in, rte.cpcr@kerala.gov.in

Website : www.kescpcr.kerala.gov.in

Child Helpline - 1098, Crime Stopper - 1090, Nirbhaya - 1800 425 1400

Kerala Police Helpline - 0471 - 3243000/44000/45000

Online ***R. T. E Monitoring : www.nireekshana.org.in***