PHYSICS
Standard X

Part - 1

Government of Kerala
Department of Education

State Council of Educational Research and Training (SCERT) Kerala
2016

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 my parents, teachers and all elders respect, 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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Dear students,

You were provided with opportunities to observe your surroundings and engage in simple experiments and investigative activities in earlier classes. The classroom experience, undoubtedly, might have helped you to record the information systematically and assimilate ideas through discussion and analysis. While understanding the scientific approach, there should also be the attitude to take forward the skills to apply them in day-to-day life. Moreover, an eco-friendly perspective must be adopted too. All these, through direct experiences, enquiry and understanding preferably.

This textbook presents ideas in accordance with this. There are experiments, illustrations and explanatory details that enable the comprehension of these ideas. There are opportunities appropriate to the situation to make learning more enjoyable.

Go ahead, thinking, asking questions, approaching ideas critically and quizzing with teachers and friends.

Make learning a joyful experience.

Regards,

Dr. P. A. Fathima
Director, SCERT

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Content

Certain icons are used in this textbook for convenience

 *For further reading (Evaluation not required)*

 *ICT possibilities for making concepts clear*

 *Significant learning outcomes*

 *Let us assess*

 *Extended activities*

1 Wave Motion

After placing a paper boat in a pond, the child kept on making ripples on the water to move it away from the shore. But it moved only up and down and he could not make it move forward.

What may be the reason?

You might have seen ripples on water when a stone is dropped into it. How does the disturbance produced by the stone in water spread to other areas? It spreads like expanding concentric circles.

Let's examine the motion of the water particles.

Fill half of a trough with water. Place some crumbled paper balls in it.

Make ripples on the surface of the water using your finger.

What do you observe?

Haven't you seen the disturbance spreading from its origin to other places? Such a motion is the wave motion.

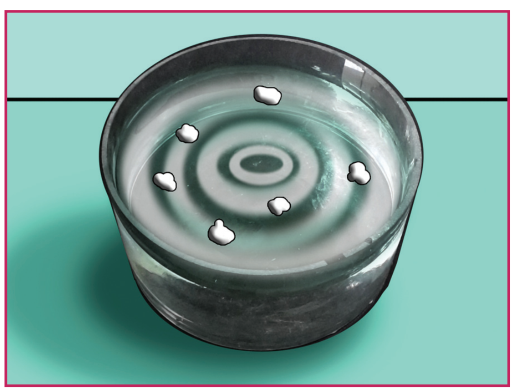


Fig 1.1

Mechanical waves and electromagnetic waves

Waves can be classified mainly into two types:

1. Mechanical waves

The presence of a medium is required for the transmission of these waves.

Eg: The waves formed on the surface of water, sound waves etc.

2. Electromagnetic waves

Electromagnetic wave is a combined form of an electric field and a magnetic field which vary continuously. A medium is not essential for its propagation.

Eg: radio waves, light waves.

- Was there a displacement of the crumbled paper?
- What type of movement will each water particle have?

Water particles move up and down about their mean position without displacement in the direction of propagation of wave. Wave motion is one of the means to make energy reach from one point to another. Energy is transferred from particle to particle and spreads everywhere due to wave motion.

Wave motion

Wave motion is the propagation of disturbances, produced on one part of a medium by the vibration of its particles, to all its other parts.

Write down examples of wave motion that you see around.

- Waves on water
-

Let's understand more about mechanical waves:

There are two types of mechanical waves. (1) Transverse waves (2) Longitudinal waves.

Transverse wave

Let's try an activity

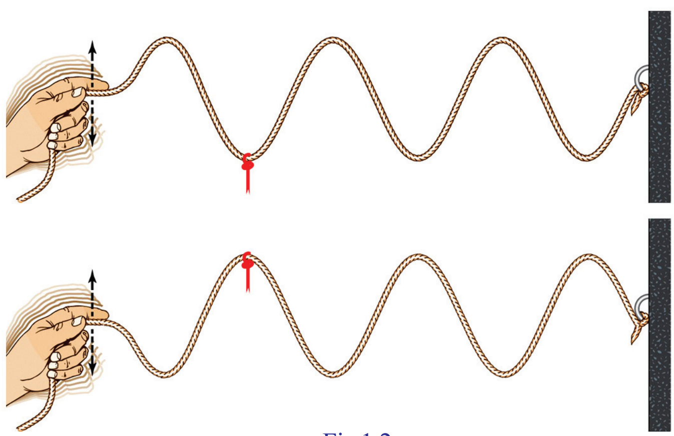


Fig 1.2

See 'Wave on a String' in PhET in the IT @ School Edubuntu.

Tie one end of a rope to a window. Wind a ribbon or paper on the rope in such a way that you can see it clearly. Hold the other end of the rope and move it up and down. Observe the wave motion on the rope.

- How does the ribbon/paper move?
- In which direction does the wave move?

When waves are formed on the rope, all that happens is just the ribbon moving up and down whereas the ribbon's position on the rope does not change at all. The ribbon is vibrating in a direction perpendicular to the direction of propagation of the wave. That is, each particle of the wave vibrates in a direction perpendicular to the direction of propagation of the wave.

Observe the picture showing the waves formed on the surface of water.

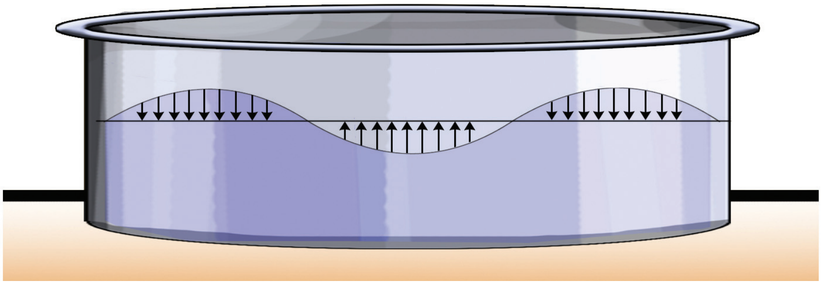


Fig 1.3

In this case, is the motion of particles parallel or perpendicular to the direction of propagation of the wave?

- -

A transverse wave is a wave in which the particles of the medium vibrate in a direction perpendicular to the direction of propagation of the wave.

Now, can't you explain why the disturbances on water could not make the paper boat move away from the shore?

Observe the graphic representation of a transverse wave at a particular instant.

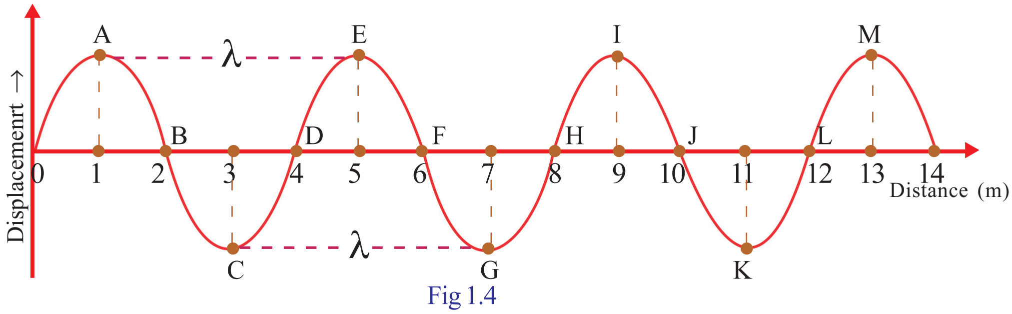


Fig 1.4

In the above figure, the portions shown elevated from the mean position are the crests. The depressed portions are the troughs.

- In the figure, which are the points of the highest displacement (amplitude)?

  A, C, ---- , ----, ----, ----

Characteristics of waves

Amplitude

Amplitude is the maximum displacement of a particle from its mean position. This is denoted by the letter **a**.

Wavelength

Wavelength is the distance between two consecutive particles which are in the same phase of vibration. This is equivalent to the distance advanced by the wave by the time a particle has completed one vibration. The Greek letter λ *(lambda)* is used to denote the wavelength. The unit is metre (m).

Frequency

Frequency is the number of vibrations in one second.

$$\text{Frequency} = \frac{\text{Number of vibrations}}{\text{Time taken}}$$

$$f = \frac{n}{t}$$

The unit of frequency is hertz (Hz).

- How many crests and troughs are there in the figure?
- Whether all the particles are in the same phase of vibration at a particular time?
- Which are the particles in the same phase of vibration as that of A?
- What about C?
- What is the wavelength of the wave shown in the figure?

Waves are formed because of the vibration of particles of a medium.

- What is the frequency of the wave if the particle **A** makes 100 vibrations in 5 s?

  ....

- In the given figure, the wavelength is 4 m. The particles of the wave completed 20 vibrations in one second. Let's find out the distance travelled by the wave in 1 s.

  Wavelength λ = 4 m

  The number of vibrations produced in one second f =20 Hz

The distance travelled by the wave in one second = number of vibrations in one second × distance travelled by the wave by the time a particle completes one vibration.

= 20 × 4

= 80 m

Distance travelled in unit time = 80 m

That is, the speed of the wave (v) = 80 m/s

The speed of a wave is the distance travelled by the wave in one second. Its symbol is v.

$$v = f\lambda$$

The unit of speed is m/s.

The graphical representation of two waves of the same amplitude, generated at specific intervals of time, is given below.

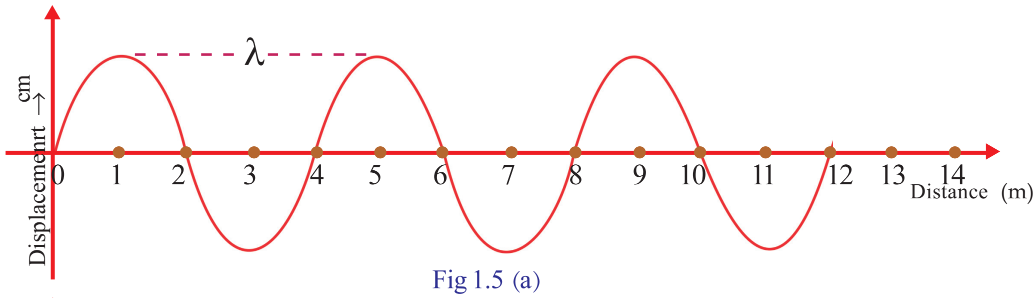


Fig 1.5 (a)

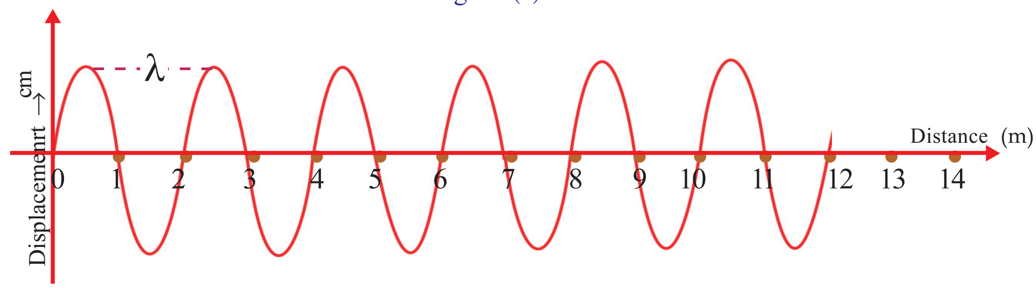


Fig 1.5 (b)

- What is the wavelength of the first wave? What about the second one?
- Which wave has a higher wavelength?
- Calculate the frequency of each wave if they have travelled this distance (12 m) in 0.25 s.
- What change takes place in the wavelength when the frequency increases?

From this, it can be understood that the wavelength of a wave with a constant speed decreases with increase in frequency. That is, frequency is inversely proportional to the wavelength.

Observe the graphic representation of a wave motion given below.

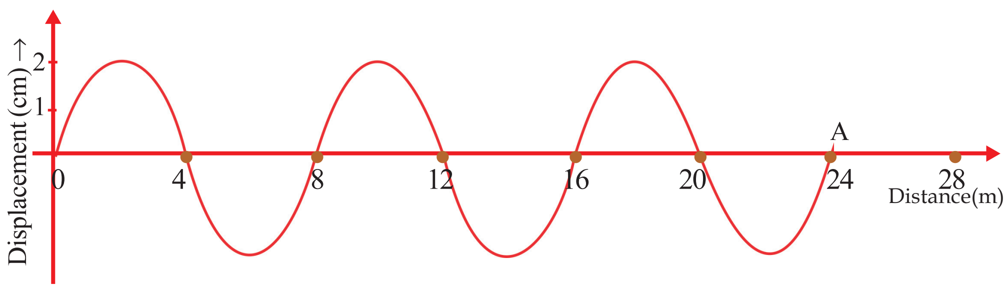


Fig 1.6

a) What is the amplitude of the wave?

b) What is the wavelength?

c) Calculate the frequency of the wave if it took 0.2 s to reach A.

d) Calculate the speed of the wave.

Is there any mode of propagation of the wave other than the transverse form? Let's examine.

Longitudinal wave

Let's do an activity using a slinky.

Fix one end of a slinky to a wall. Hang some pieces of paper on the coils at equal distances. Press a few coils on the free end held in the hand and then release them.

What do you observe?

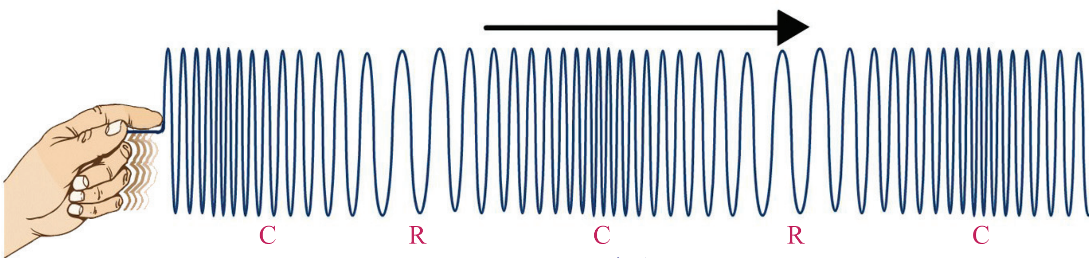


Fig 1.7

- Won't the air particles vibrate to and fro when such waves pass through the air?

  High pressure is experienced in places where the air particles are close. Such a region is the compression (C).

  In that case, what about the part in which the molecules are wide apart?

  Regions of low pressure are the rarefactions (R).

A longitudinal wave is a wave in which the particles of the medium vibrate in a direction parallel to the direction of propagation of the wave. This creates compressions and rarefactions alternately in the medium.

See 'Sound Waves' in PhET in the IT @ School Edubuntu.

Let's see how we hear a sound from a source.

Listen to the sound from an excited tuning fork. Take a look at Fig. 1.9 which illustrates how the sound waves reach our ears.

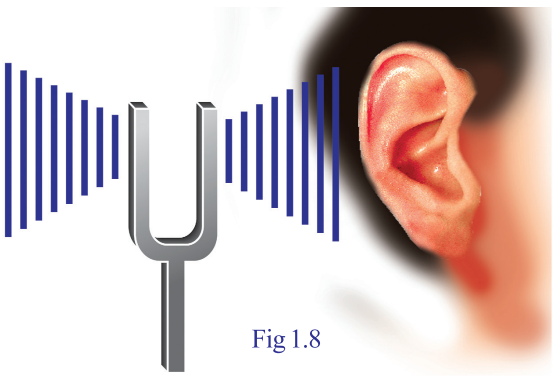


Fig 1.8

Won't the vibrations of the tuning fork make the air particles around it to vibrate?

Compare the waves formed on the slinky, with the longitudinal waves produced by the tuning fork in the air.

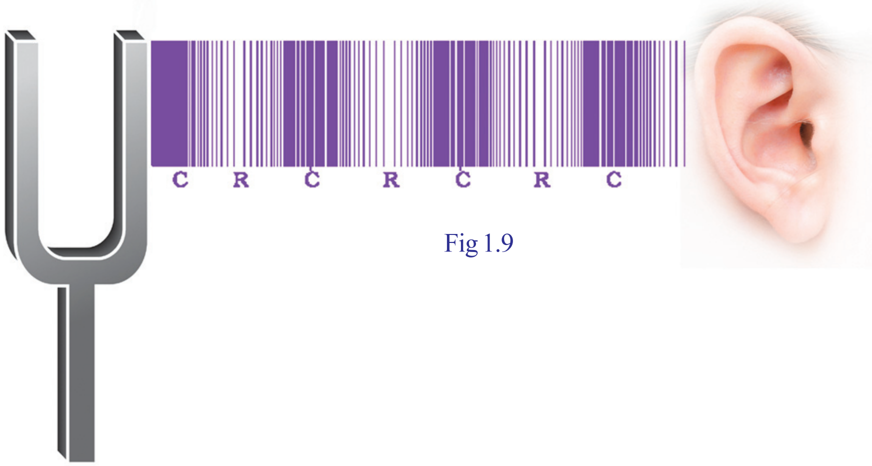


Fig 1.9

- How many compressions are there in the longitudinal wave shown in the figure?
- Find out the differences between transverse and longitudinal waves and complete the table.

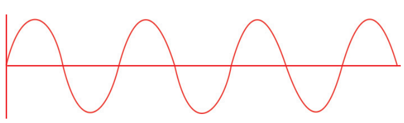
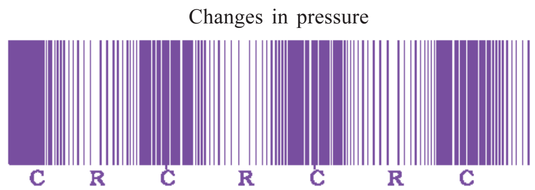
Transverse wave	Longitudinal wave
1. 	1. 
2. Particles vibrate in a direction perpendicular to the direction of propagation of the wave.	2. Particles vibrate in a direction parallel to the direction of propagation of the wave.
3.	3. Compressions and rarefactions are formed.
4. Formed on the surface of solids and liquids.	4. ....

Table 1.1

The seismic wave formed during an earthquake is another example of a longitudinal wave.



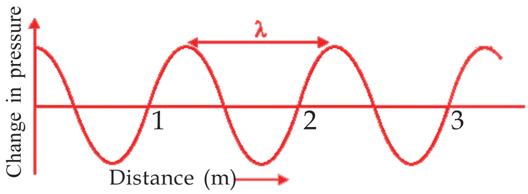


Fig 1.10

Longitudinal wave

The distance between corresponding points of two consecutive compressions or two consecutive rarefactions is the wavelength of the longitudinal wave.

	Medium	Velocity (m/s) (at 20° C)
Solid	Aluminium	6420
	Steel	5941
Liquid	Pure water	1482
	Sea water	1522
Gas	Air	343
	Helium	965

Sound

Haven't you learnt that a medium is essential for the propagation of sound? Let's see how do sound waves are propagated through a medium. Observe the figure which shows how a sound coming from a source produces a continuous change in the pressure in a medium.

- What do C and R in the figure indicate?
- Find out the wavelength in Fig.1.10 and write it down.
- What is the speed of the wave if its frequency is 92 Hz?

Is the speed of sound the same in all media?

Let's see.

Speed of sound

Ask your friend to tap continuously on a desk.

Do you hear any sound?

What is the medium through which the sound reached you?

Now repeat the activity, keeping your ear closely pressed to the desk.

Through which media did the sound travel to reach your ear?

Haven't you understood that sound can travel through air and wood? The speed of sound differs from one medium to another. One of the reasons for this is the difference in the density of the media.

Will the speed of sound in air be the same in all situations?

Observe the situations given below.

- We can hear sounds from a longer distance during the monsoon.
- There is a fluctuation in the speed of sound when there is wind.
- On a hot day, the density of air decreases and the speed of sound increases.

What are the factors that influence the speed of sound through air?

- Humidity
- Density
-

You have learnt that the speed of sound in a medium can change with a change in the surroundings?

Haven't you learnt about other characteristics of sound in earlier classes. Write them down.

- Loudness
-

Humidity and speed of sound

The amount of water vapour in the air is humidity. It is less during winter and high in summer. The speed of sound increases with increase in humidity. This is because the density of air decreases with the increase in humidity.

Take seven identical glasses containing different amounts of water. Arrange them in the order of increasing amounts of water as shown in the figure. Tap each glass gently using a pencil.

Listen to the sound. What difference do you feel? Why is it so?

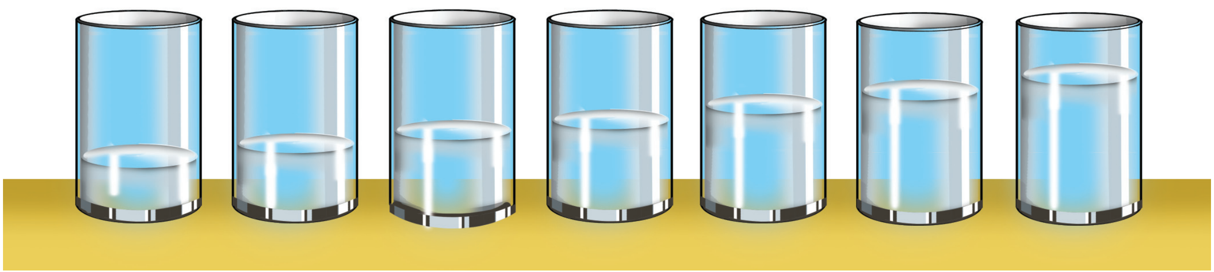


Fig 1.11

Let's see.

Excite two tuning forks of frequencies 512 Hz and 256 Hz and listen to the sounds from them. Isn't there a difference in the sound? Isn't this because the tuning forks vibrated freely in their natural frequencies?

The natural frequency of an object is the frequency at which it vibrates freely.

Press the stem of an excited tuning fork on a table.

Doesn't the sound increase? Why?

- What influenced the table to vibrate?

  You might have realised now that there was an increase in the loudness of sound since the table also vibrated.

- How did the table vibrate? Is it in its natural frequency or that of the tuning fork?

Such a vibration of the table is forced vibration.

> ***Forced vibration***
>
> *A body undergoing vibration under the influence of a vibrating body, with the same natural frequency as that of the influencing body, is forced vibration.*

The sound increased as the table had a larger surface area.

This led to the increase in loudness as well.

Devices that make use of forced vibration are given below.

Fig 1.12

Device	Vibrating part	The part undergoing forced vibration
Guitar	String	Sound board, air
Chenda	Leather	Air, wooden part

Table 1.2

- What will be the result if the natural frequency of an influencing body is the same as that of the influenced body?

Let's try an activity.

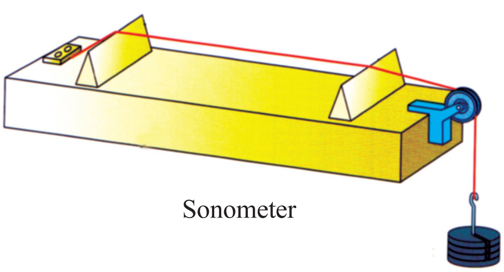
Resonance

Bring the bridges of a sonometer close to each other. Put a paper rider on the string between the bridges. Excite a tuning fork and press its stem on to the sonometer board. Observe the paper rider.

- Why did the paper rider vibrate?

Adjust the distance between the bridges and repeat the process several times and find out the instance when the paper rider is thrown off.

- What happens to the length of the segment of the string when the distance between the bridges increases?



Sonometer

Fig 1.13

What will happen to the frequency of the string on increasing its length? Will the natural frequency of the tuning fork coincide with that of the string on reaching a particular length?

In such situations the amplitude of vibration of the string increases, causing the paper rider to be thrown off. Now the tuning fork and the sonometer are in resonance.

Two objects in vibration are said to be in resonance if the natural frequency of the body undergoing vibration is the same as that of the influencing body. This is an occasion when the body vibrates with maximum amplitude.

Resonance of air

Excite a tuning fork of frequency 512 Hz and hold it close to the mouth of a resonance column. Slowly raise the inner tube. Is the sound gradually increasing?

- Find out the situation in which the loudness is maximum.
- What may be the reason behind the maximum loudness of sound?

When the natural frequency of tuning fork and air column is equal, they are said to be in resonance. Now the loudness increases due to the increase in the amplitude.

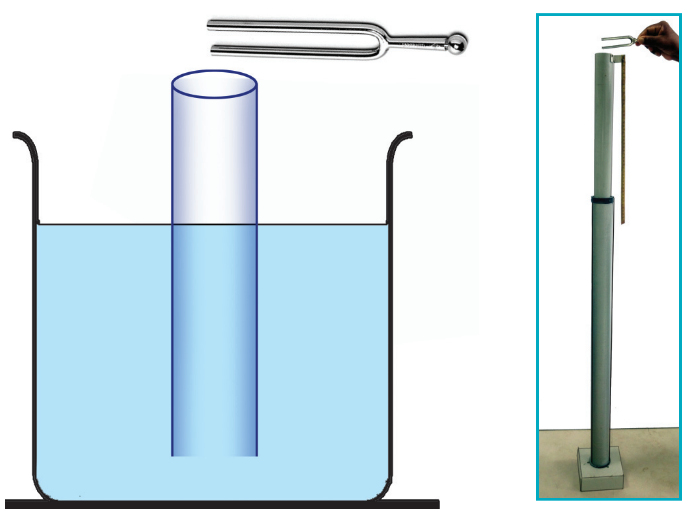
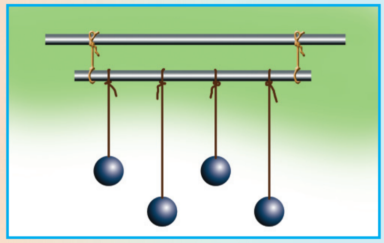


Fig 1.14

Pendulum and resonance

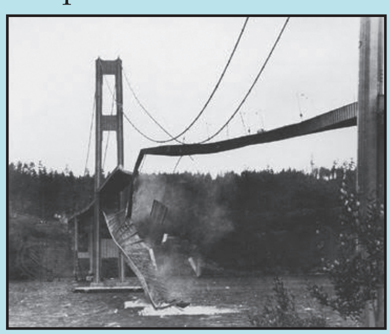


Hang four bobs as shown in the figure. When the first ball is allowed to oscillate, the third one also oscillates with the same amplitude. Similarly when the second ball is allowed to oscillate, the fourth one also oscillates with the same amplitude. This is because the pendulums of the same length are in resonance.

Tacoma narrows bridge collapses

This is a picture showing the collapse of the Tacoma Narrows Bridge in Washington in America in 1940.

The suspension bridge happened to be in resonance with wind of speed 15 m/s on 7 November 1940 and it collapsed in seconds.



Repeat the experiment using tuning forks of different frequencies and find the instances of resonance.

Explain the following on the basis of resonance.

- Window panes vibrate and produce sound when there is thunder.
- Soldiers are not allowed to march across suspension bridges.
-

Reflection of sound

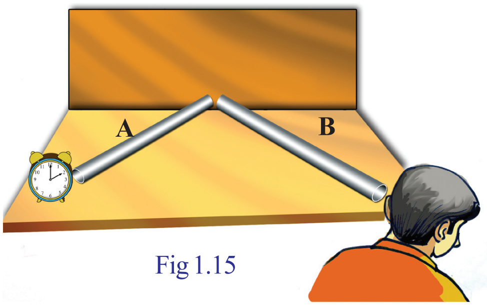


Fig 1.15

Haven't you learnt that light is reflected when it hits smooth surfaces?

Can sound waves get reflected like this?

Let's try.

Arrange two PVC pipes, a glass plate and a stop clock as shown in the figure.

- What may be the reason behind hearing the sound through the pipe B?

Isn't it due to the reflection of sound from the glass plate? In a similar way bats catch prey by detecting the reflected sound from obstacles and can sense if there is any obstruction. Sound gets reflected very well from smooth surfaces.

Multiple reflection of sound

Fig 1.16 shows how sound from a source reaches a listener or receiver in closed room or a hall.

- Does sound from a source reach a listener only directly?
- Is there a chance of reflected rays getting reflected again?
- What will be the auditory effect of such a sound?

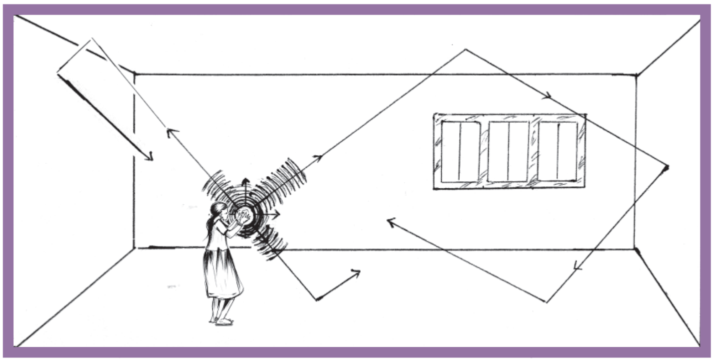


Fig 1.16

Sound getting reflected repeatedly from different objects is multiple reflection.

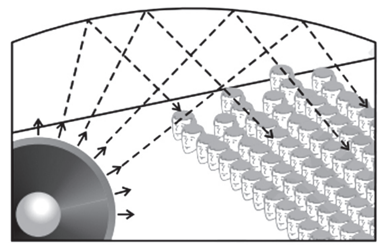
Situations making use of multiple reflection

- Devices like megaphone, horns, musical instruments like shehanai and trumpets, are made in such a way that the sound produced from them travels only in a certain direction without spreading to other directions.

  In such devices there is a conical shaped open end which enables the reflected sounds to travel in a particular direction alone, thus enabling us to hear it louder.

- Stethoscope

  Helps us to detect beats in the body especially heart beats.



- The ceilings of halls are given a curvature.

  As a result sound undergoes multiple reflection and spreads everywhere in the hall.

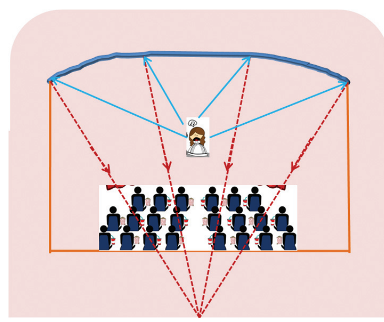


Fig 1.17

- Sound boards

  The curved sound boards placed behind the screen makes the sound undergo multiple reflections and spreads everywhere in the hall. The boards in musical instruments like guitar, violin etc., also act as sound boards.

Reverberation

Haven't you felt a boom of sounds in empty rooms? What may be the reason?

- Which are the regions where sound waves in a room get reflected?
- Do these repeatedly reflected sound waves reach the ear of a listener simultaneously?
- Will you be able to hear all these sounds clearly due to the persistence of audibility? Won't you be hearing only a boom of all the sounds?

Persistence of audibility

The sensation of hearing produced by a sound is retained for a period of $\frac{1}{10}$ s = 0.1 s. This characteristics of the ear is the persistence of audibility. If another sound reaches the ear within 0.1 s, simultaneous hearing of both the sounds is experienced.

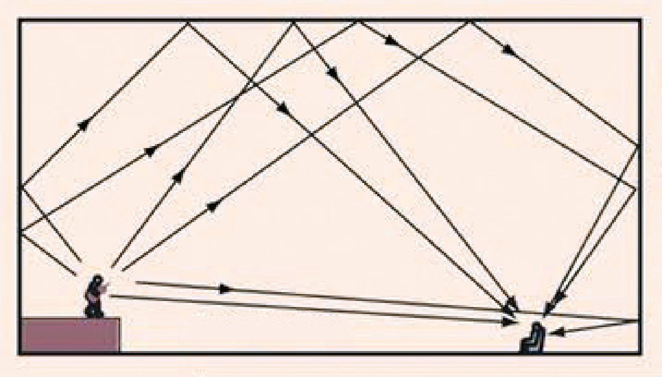


Fig 1.18

This boom is the reverberation.

Reverberation is the persistence of sound as a result of multiple reflection.

To hear the first sound clearly after reflection, what should be the minimum distance between a listener and an obstacle?

Echo

How long does it take to hear clearly the reflected sound of the first sound?

What distance will the sound travel by this time? What should be the minimum distance to the reflecting surface if the velocity of sound in air is 340 m/s?

Are you convinced that the same sound can be heard again, if the reflecting surface is at a distance of more than 17 m? This phenomenon is the echo.

The phenomenon of hearing a sound by reflection from a surface or obstacle, after hearing the original sound is the echo.

Write down the situations in which echo is heard.

-

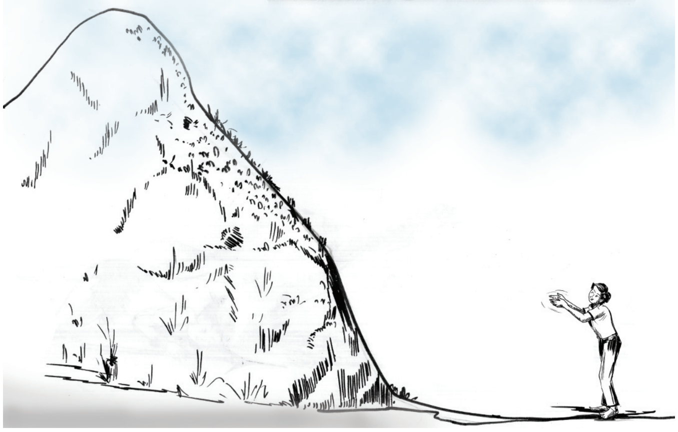


Fig 1.19

- A person who bursts a cracker hears its echo after 1 s. What is the distance to the reflecting surface if the speed of sound in air is 340 m/s?

Let d be the distance to the reflecting surface. If so, the total distance travelled by the sound in this time is 2d.

$$\text{Speed of sound} = \frac{\text{Total distance travelled}}{\text{Time}}$$

$$v = \frac{2\,d}{t}$$

$$d = \frac{v \times t}{2} = \frac{340 \times 1}{2} = 170\,m$$

- What should be the minimum distance between the source and the reflecting surface in water to identify the echo within water? (speed of sound in water is 1482 m/s)

Acoustics of buildings

Haven't you seen the walls with rough surfaces in big halls like the cinema theatres? Why are the walls made rough?

- With respect to reflection of sound, what are the problems if the distance between the walls in a room is more than 17 m?
- What are the methods to minimise the problems that occur due to reflection of sound?
- What all things can we do in halls to increase audibility?
- Make the floor rough.
-

Acoustics of buildings is the branch of science that deals with the conditions to be fulfilled in the construction of a building for clear audibility.

It is the waves that carry pleasant sounds. Have you heard of damages caused by tsunami? Do you know that it is due to the seismic sound waves created by the earthquakes?

Whispering gallery

The Whispering Gallery at St. Paul's Cathedral in London is the best example for the reflection of sound. Even if you are only whispering near the circular wall below the dome, the sound will be heard loudly anywhere within the gallery. This is due to the multiple reflection of sound from the circular walls. The Gol Gumbas in Bijapur of Karnataka is another example.

The Gol Gumbas

Seismic waves

Seismic waves formed in nature are behind this damage shown in the figure. The seismic waves originate from the epicentre of the earthquake. The amplitude of the seismic waves determines the intensity of an earthquake. Do you know that the intensity of earthquakes is measured in Richter scale?

Scene of Nepal disaster

Fig 1.20

Seismic waves

Waves travelling through layers of the earth due to big explosions, earthquakes and volcanic explosions are the seismic waves. Using hydrophone and seismometer, we can study these waves and record them. Seismology is the branch of science that deals with the study of seismic waves. Scientists dealing with the study of seismic waves are seismologists.

What are the after effects of earthquakes? Write them down.

- damage to buildings
-

All living beings except humans can recognise these destructive waves and they escape. Methods are being developed now to know them in advance.

Collect more information regarding this.

Conduct a mock drill to make your friends aware of the precautions to be taken during earthquakes.

Significant Learning Outcomes

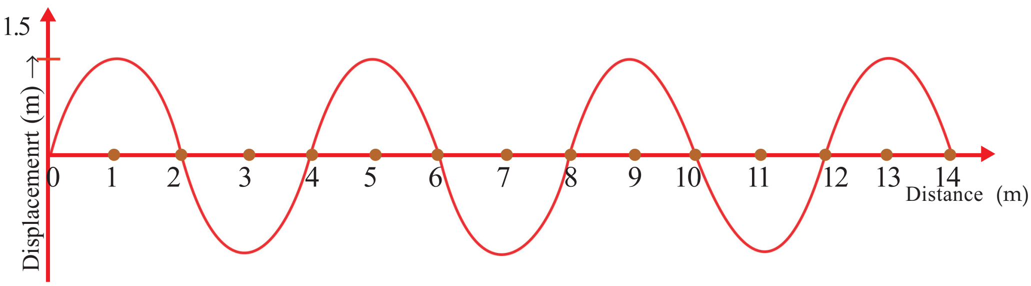
The learner can

- distinguish between different types of waves and classify them as transverse and longitudinal.
- explain the relation between frequency of a wave, wavelength and speed and can solve related numerical problems.
- explain how sound waves are propagated through air.

- explain multiple reflection, reverberation, echo and speed of sound, and can solve numerical problems.
- explain forced vibration, resonance and cite examples for equipment that make use of forced vibration.
- explain facts related to acoustics of buildings and their importance.
- know in advance the impacts of destructive seismic waves in nature, take precautions to overcome them and help in rescue work.

Let us assess

1. Observe the graph.



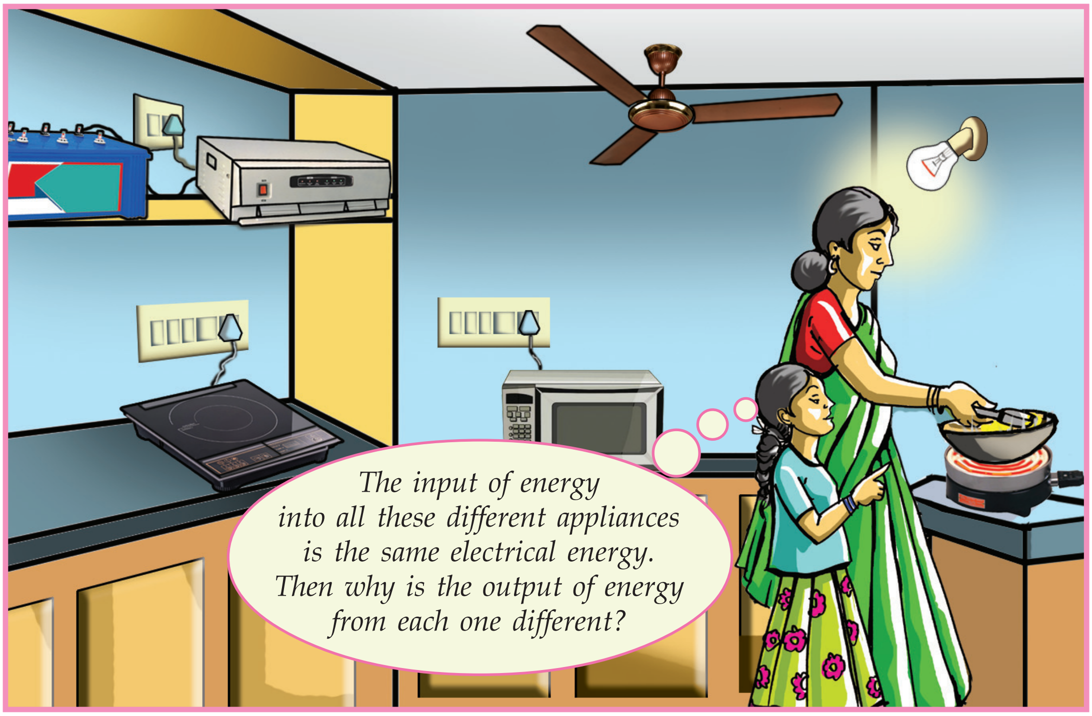
- Find out the amplitude of the wave.
- What is the speed of the wave if it travels 800 m in 2 s?
- What is the frequency of the wave?

2. What do you mean by acoustics of buildings? Suggest four steps that can be taken, while constructing buildings, to avoid problems that may occur due to multiple reflection of sound.
3. A sound signal from a ship floating on water, hits a rock at the bottom of the sea and comes back to the ship after 4 s. Calculate the distance of the rock from the surface of water. The speed of sound in water is estimated to be 1500 m/s.

Extended activities

1. Using plastic pipes make a device which resembles a resonance column and exhibit it in the science club.
2. Visit a nearby cinema theatre, find out what has been done there in connection with acoustics of buildings and prepare a short note.
3. Study the role of the shape of a veena in utilising forced vibration and prepare a short note.

2 Effects of Electric Current



Did you notice the doubt of the child?

What are the effects of electric current in the different appliances shown in the above figure?

Write down the change of energy in each.

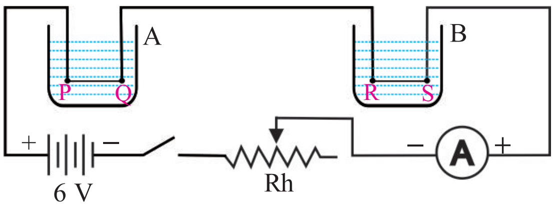
• Electric stove	:	electrical energy	→	heat energy	→	heating effect
• Electric bulb	:	....	→	....	→	....
• Electric fan	:	....	→	....	→	....
• Storage battery (charging)	:	....	→	....	→	....
• Induction cooker	:	....	→	....	→	....
• Electric oven	:	....	→	....	→	....

Table 2.1

You might have studied the chemical effect of current in your chemistry class.

Heating effect of electric current

Make a circuit as shown in Fig. 2.1.



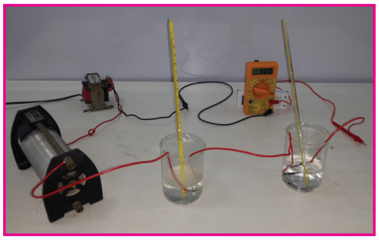


Fig 2.1

A and B are two beakers of 200 mL capacity. Each beaker contains 100 mL of water. PQ is a nichrome wire. RS is a copper wire of the same length and diameter as the nichrome wire. Measure the temperature of water in the beakers A and B using a thermometer. When switched on, isn't it the same current that passes through PQ and RS? Observe the ammeter reading. Measure the temperatures of water in the two beakers after three or four minutes. What difference do you observe?

- Which is the conductor that produced a higher temperature?

  -

- And the lower?

  -

- Why did the temperature of water in the beaker containing nichrome increase?

  -

Pass current first for 5 minutes and then for 7 minutes through the nichrome wire in the beaker A.

- In which case do you get a higher temperature?
- Why is it that the temperature increases with the time of flow of current?

Adjusting the rheostat, in the circuit, can't you increase the current? Repeat the experiment by increasing the current. After three or four minutes, observe the change in temperature. Your observations may be noted in the science diary.

The factors that affect the heat generated in a current carrying conductor are:

- Electric current

- Resistance of the conductor
-

The scientist James Prescott Joule discovered the relation connecting them.

Joule's Law

The heat generated in a current carrying conductor is the product of the square of the current (I) in the conductor, the resistance of the conductor (R) and the time (t) of flow of current.

If H is the heat generated,

$$H = I^2Rt$$

I is measured in ampere, R in ohm and t in second

- If the current through the conductor is doubled using a rheostat, how many times will the heat generated increase?

  $H = I^2Rt$

  If I is doubled,

  $H = (2I)^2 \times Rt$

  $= 4\,I^2Rt$

  When the current in a circuit is doubled, heat generated becomes four times.

- If the current is halved, what happens to the heat generated?

- A current of 0.2 A flows through a resistor of resistance 200 Ω for 5 minute. How much is the heat generated?

  $R = 200\ \Omega$

  $I = 0.2\ A$

  $t = 5 \times 60\ s$

  $H = I^2Rt$

  $H = (0.2)^2 \times 200 \times 5 \times 60$

  $H = 2400\ J$

We can formulate other equations to find out the heat generated in a conductor when current passes through it.

According to Ohm's Law,

$$V = I \times R$$

If we substitute the value of $\frac{V}{R}$ for I in $H = I^2Rt$

$$H = \left(\frac{V}{R}\right)^2 \times Rt = \frac{V^2Rt}{R^2}$$

That is, $H = \frac{V^2t}{R}$

- Similarly, replace R with $\frac{V}{I}$ in $H = I^2Rt$ and write down the equation. What is the equation for H?
- A bulb of resistance 920 Ω works on 230 V supply. Calculate the quantity of heat generated in 3 minutes.

$V = 230$ V

$R = 920\ \Omega$

$t = 3 \times 60$ s

$$H = \frac{V^2t}{R}$$

$$= \frac{230^2 \times 3 \times 60}{920}$$

$H = 10350$ J

Solving by another method.

$V = 230$ V, $R = 920\ \Omega$

$$I = \frac{V}{R} = \frac{230}{920} = \frac{1}{4}\text{A}$$

$H = I^2Rt$

$$= \left(\frac{1}{4}\right)^2 920 \times 3 \times 60$$

$= 10350$ J

Solve the same problem using the equation $H = VIt$.

- An electric iron works on 230 V. A current of 3 A flows through this for half an hour. Calculate the amount of heat energy generated.

Instruments that make use of heating effect of electric current are electric heating appliances.

A few heating appliances are shown in Fig. 2.2. In such instruments, heat is produced in the heating coil.

Fig 2.2

Appliances without heating coil

Microwave oven and induction cooker are appliances which do not use a heating coil. In a microwave oven, microwaves are used and induction cooker uses eddy currents.

Heating coils are made of nichrome. Nichrome is an alloy of nickel, chromium, iron and manganese.

Let's see what advantages of nichrome are made use of in electric heating appliances.

- high resistivity
- high melting point
- ability to remain in red hot condition for long time without getting oxidised

Safety fuse

Safety fuse is a device that works on the heating effect of electric current. Let's see how it works.

The main part of safety fuse is a fuse wire. It is an alloy of suitable metals. Fuse wire has a low melting point. In each circuit, a fuse wire of suitable amperage is used.

- Which are the circumstances that cause high electric current, leading to the melting of fuse wire?

- How is the fuse wire connected in a circuit? In series/ parallel?

- You know that when electric current is increased, more heat will be produced, in accordance with Joule's law. What happens to the fuse wire due to this?

- When heat is generated, why does the fuse wire melt?

- When fuse wire melts, circuit is broken. What happens to the current in the circuit?

Why is the fuse used in a circuit called safety fuse? Explain.

Fig 2.3

Short circuit and overloading

If the positive and the negative terminals a battery or the two wires from the mains come into contact without the presence of a resistance in between, they are said to be short-circuited.

A circuit is said to be overloaded if the total power of all the appliances connected to it is more than what the circuit can withstand.

During the entire time of the passing of current through a circuit, a small amount of heat is generated in the fuse wire. But this heat will be transmitted to the surroundings. When the current that flows into the circuit exceeds the permissible limit, the heat generated becomes excessive. Since more heat is generated in unit time than the heat transmitted, the fuse wire melts.

Safety fuse is a device which protects us and the appliances from danger when an excess current flows through the circuit.

Is the current passing through different circuits the same? Intensity of electric current differs from one appliance to another. Hence fuse wires of appropriate amperage should be selected.

When a fuse wire is included in a household wiring, what are the precautions to be taken? Let's see.

- The ends of the fuse wire must be connected firmly at appropriate points.
- The fuse wire should not project out of the carrier base.
-

Lighting effect of electric current

In early days, filament lamps were widely used. Observe the parts of a filament lamp shown in Fig. 2.4.

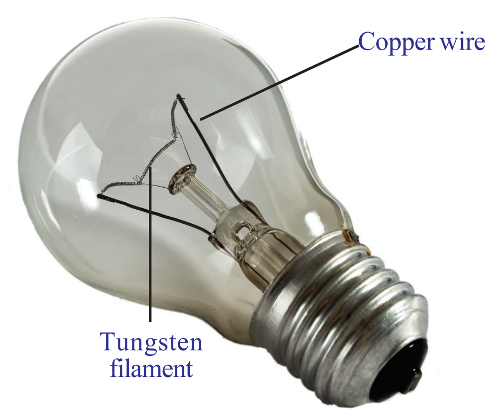


Fig 2.4

Gauge

Gauge is the reciprocal of the diameter of a conductor. As the gauge increases, the thickness of the conductor decreases and hence the amperage also decreases.

Amperage

Amperage (A) is the ratio of the power of an equipment to the voltage applied. Amperage increases with the thickness of the conductor.

Incandescent lamps

In ordinary voltages, the filament becomes white hot and gives out light. Such bulbs are the incandescent (glowing with heat) lamps. Filaments made of the metal tungsten are used in them. Tungsten can become white hot and emit white light for a long time. In order to avoid oxidation of tungsten, the bulb is evacuated. Vaporisation can be reduced by filling some inert gas at low pressure inside the bulb. Nitrogen is usually used for this purpose now.

Why Nitrogen?

At ordinary temperature and pressure, nitrogen behaves like an inert gas. Small increase in temperature does not influence the expansion of nitrogen. The ready availability of nitrogen in nature is one reason for using it in bulbs. In the absence of air within the bulb this gas behaves completely as an inert gas.

- What happens if the interior of the bulb is not evacuated?

  -

- Why is the bulb filled with an inert gas/ nitrogen?

  -

- What are the advantages of using tungsten as a filament?
  - high resistivity
  - high melting point
  - high ductility
  - ability to emit white light in the white hot condition

- Nichrome is not used as filament in incandescent lamps. Why?

  -

- A filament lamp is lit for a short period of time. Touch it. What do you feel?

  -

Haven't you understood that a major part of the electricity supplied to an incandescent lamp for obtaining light is lost as heat?

A major part of the electrical energy supplied to an incandescent lamp is lost as heat.

By now it may be clear to you why the use of incandescent lamps is to be restricted.

What are the other types of lamps working on electricity? List them.

- Discharge lamp
- Fluorescent lamp
- Compact Fluorescent Lamp (CFL)
- LED lamp
- Arc lamp
-

Discharge lamps

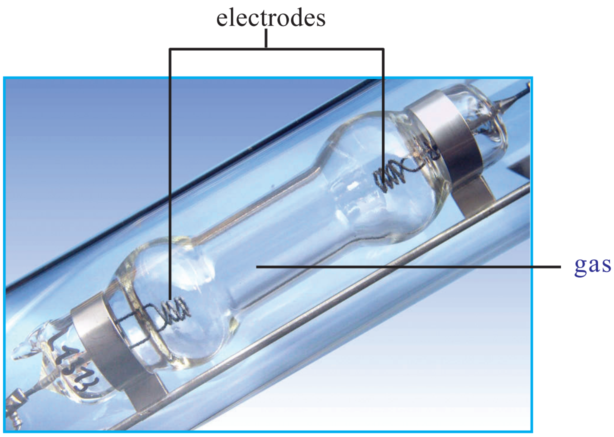


Fig 2.5

- What are the parts of a discharge lamp?

When a discharge lamp is connected to a source of electricity, the gas in between the electrodes gets ionised due to the applied potential difference. Ionised atoms move at high speed and collide with unionised atoms among them and excite them to higher energy states. Excited atoms come back to their original states for attaining stability. During this process the energy stored in them will be radiated as light. The colour of the light depends on the gas inside the discharge lamp.

Gas	Colour
Hydrogen	Blue
Sodium vapour	Yellow
Neon	Orange red
Chlorine	Green
Nitrogen	Red

Situations where heating effect of filament lamps employed

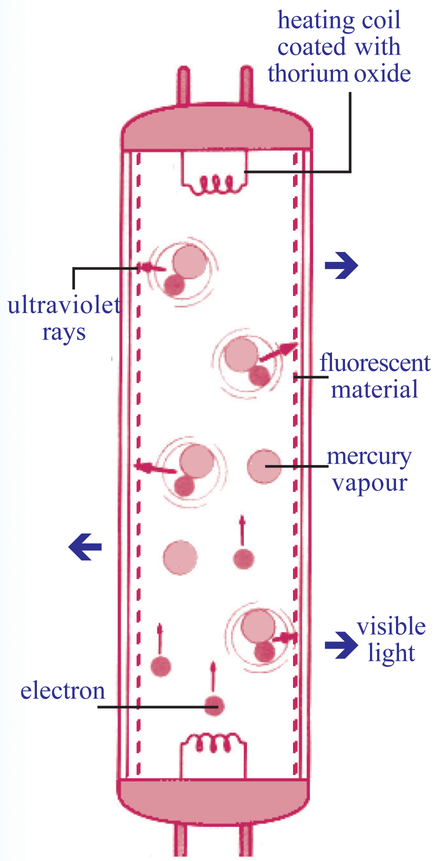
In the field of medical treatment, powerful filament lamps are used for producing infrared rays. In this, there are reflectors capable of producing heat by focusing radiations on the required parts.

Such filament lamps are used in poultry farms for producing heat.

See 'Neon lights and other discharge lamps' in PhET IT @ School, Edubuntu.

- How does electric discharge occur between the electrodes of a discharge lamp?
- Why do the excited electrons give out energy?

Discharge lamps are of different types. Fluorescent lamp is one among them.



Fluorescent lamp

Fig 2.6

Fluorescent lamps

The white substance coated inside a fluorescent lamp is the fluorescent material. This gives a white colour to the lamp. At the two ends of the tube there are two heating coils coated with thorium oxide. Due to the flow of electric current, the heating coils become very hot and electrons are emitted. Thorium oxide is coated to increase the electron emission efficiency.

The rapidly moving electrons collide with unionised molecules of the mercury vapour. As a result, ultra violet rays are produced. These rays are absorbed by the fluorescent material and re-emitted as visible light.

In modern fluorescent lamps, electronic ballasts are used. The 50 Hz domestic supply is converted to high frequency currents by using electronic circuits and is supplied to fluorescent tubes. Besides the high voltage required for initiating the discharge is also provided by the electronic ballast.

Ultraviolet rays along with blue light are produced by some fluorescent lamps. They are used as traps for flies and in banks for detecting fake notes and fake documents.

Fig 2.7

Compact fluorescent lamps (CFL)

Compact fluorescent lamps are designed to work at low power. The length of the tube is reduced considerably compared to that of a fluorescent lamp. The working of both the fluorescent lamps and the compact fluorescent lamps are almost similar. The glass tube of CFL is connected to that part which contains electronic circuits.

Both the fluorescent lamp and the CF lamp contain mercury vapour which is detrimental to environment. Hence they should not be thrown out carelessly after use.

Seminars may be arranged to campaign against this menace. Prepare posters to create a social awareness about this consequence.

LED lamp gives more light but consumes less electrical energy.

Light emitting diode lamps (LED Lamps)

The full form of LED is light emitting diode.

Advantages of LED lamps

- As there is no filament, there is no loss of energy in the form of heat.
- Since there is no mercury in it, it is not harmful to environment.
- It requires only a small quantity of power.

One way of overcoming the energy crisis is to use more LED lamps.

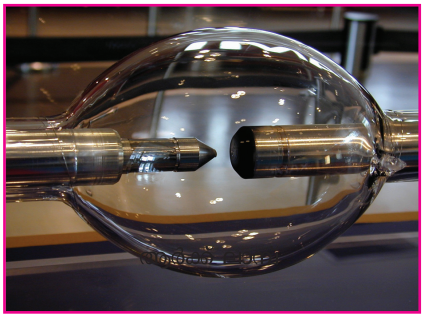
Prepare a note on the possibilities of LED lamps by collecting more information about them.

LED lamps
Fig 2.8

Arc lamps

What are the uses of arc lamps?

Arc lamps are used in search lights, film shooting and for rescue work during night time. In early days, arc lamps were used in cinema projectors and in places where intense light was required. Carbon rods kept at a fixed distance in an evacuated glass tube are the major part of this. Electric discharge produced when a high voltage is applied between them gives bright light to the arc lamp.



Arc lamps
Fig 2.9

Electric power

You might have noticed the marking of 500 W on an electrical appliance. What does it indicate? An electrical appliance works by making use of electrical energy. Hence it has a power.

You have studied in the earlier class that power is the work done per unit time.

> *The amount of energy consumed by an electrical appliance in unit time is its power.*

Power is calculated using $P = \frac{W}{t}$

- What is the unit of power?
- According to Joule's Law, the heat generated (H) in an electrical circuit in an interval of time t second or the work done is H = ... Then, how is the power calculated?

Work done $H = I^2Rt$

$$\text{Time} = t$$

$$\text{Power, } P = \frac{\text{Work}}{\text{time}} = \frac{H}{t}$$

$$\text{Power, } P = \frac{I^2Rt}{t}$$

$$P = I^2R$$

$$\text{By Ohm's Law, } I = \frac{V}{R}$$

$$\text{So, } P = I^2R$$

$$= \left(\frac{V}{R}\right)^2 R = \frac{V^2}{R}$$

$$\text{Thus, } P = \frac{V^2}{R}$$

If $R = \frac{V}{I}$, what will be P?

$$P = I^2R = I \times ..... = ...$$

The unit of electric power is watt (W).

- An appliance of power 540 W is used in a branch circuit. If the voltage is 230 V, what is its amperage?

$$\text{Amperage} = \frac{\text{Wattage}}{\text{Voltage}} = \frac{W}{V}$$

$$I = \frac{W}{V} = \frac{540}{230} = 2.34 \text{ A}$$

Since it is not a whole number, the next whole number is taken as the amperage. Hence, amperage = 3 A.

- A heating appliance has a resistance of 115 Ω. If 2 A current flows through it, what is the power of the appliance?

$$R = 115\ \Omega$$

$$I = 2\ \text{A}$$

$$\text{Power } P = I^2R$$

$$= 2^2 \times 115 = 460 \text{ W}$$

- A current of 0.4 A flows through an electric bulb working at 230 V. What is the power of the bulb?

- A device of resistance 690 Ω is working at 230 V. What is the power of the device?

If the broken filament of a bulb is rejoined and lighted, what happens to the power of the bulb?

Fig 2.10

- When the broken filaments were joined together, what happened to the length of the filament?

- How does the resistance change when the length decreases? When the resistance decreases, by Ohm's Law, what is the change in the strength of the current?

- When the strength of the current increases, what is the change in the power of the bulb? Write down your inference.

You have understood that the power changes when there is change in the resistance of the device. If so, what happens when the voltage given to the device is changed?

- An instrument is marked 150 W, 230 V. If the voltage is lowered to 110 V, what will be its power?
- A bulb of resistance 529 Ω works on 230 V. The filament was broken. It was joined together and made to work. Let the resistance of the filament now be 460 Ω. What is the change in the power of the bulb? What is the current flowing through the bulb?

Initially,

$$V = 230\ V$$
$$R = 529\ \Omega$$
$$P = \frac{V^2}{R}$$
$$= \frac{230 \times 230}{529} = 100\ W$$

In the second case,

$$V = 230\ V$$
$$R = 460\ \Omega$$
$$P = \frac{V^2}{R} = \frac{230 \times 230}{460} = 115\ W$$

Since the power has increased, heat generated will be more. Unable to withstand the increased amount of heat, there is a possibility that the bulb may get fused again.

Change in power = 115 - 100 = 15 W

Initial current $I = \frac{V}{R} = \frac{230}{529} = 0.4348\ A$

Final current $I = \frac{230}{460} = 0.5\ A$

Change in current = 0.5 - 0.4348 = .0652 A

- A bulb is designed to work in 230 V. The resistance of the filament is 529 Ω. If the bulb works at 115 V, what will be its power?

Power $P = \frac{V^2}{R}$

When works at 230 V

$$P_1 = \frac{230 \times 230}{529} = 100\ W$$

When works at 115 V

$$P_2 = \frac{115 \times 115}{529} = 25\ W$$

Thus, when there is no change in resistance, the power becomes $\frac{1}{4}$ times if voltage is halved. Similarly, if the voltage becomes one fourth, the power becomes one sixteenth.

- Two bulbs are marked 40 W, 240 V and 100 W, 240 V. Which one has greater resistance?

In a bulb, electrical energy is converted into light energy. Along with that, some heat energy is also produced. In a heater, there is conversion of electrical energy into heat energy. In a motor, electrical energy is converted into mechanical energy. Electrical energy can be easily converted into other forms of energy. This is the great advantage of electrical energy. But appropriate devices are to be used for the conversion. It might be clear now why different effects occur when electrical energy is passed through different appliances.

Significant Learning Outcomes

The learner can

- make a list of electrical devices that we use in everyday life and explain the energy conversions in each of them.
- explain Joule's Law and use it to solve numerical problems.
- explain the structure and working of heating appliances and record features of heating coils.
- explain the necessity and method of functioning of fuse wire in electrical circuits.
- elucidate the working of incandescent lamps and the reason for using tungsten as the filament and also the reason for loss of energy in incandescent lamps.
- explain the working of discharge lamps and how different colours of light are originated.
- explain the working of fluorescent lamps and how they cause environmental pollution.
- formulate equations related to electric power and solve related numerical problems.

Let us assess

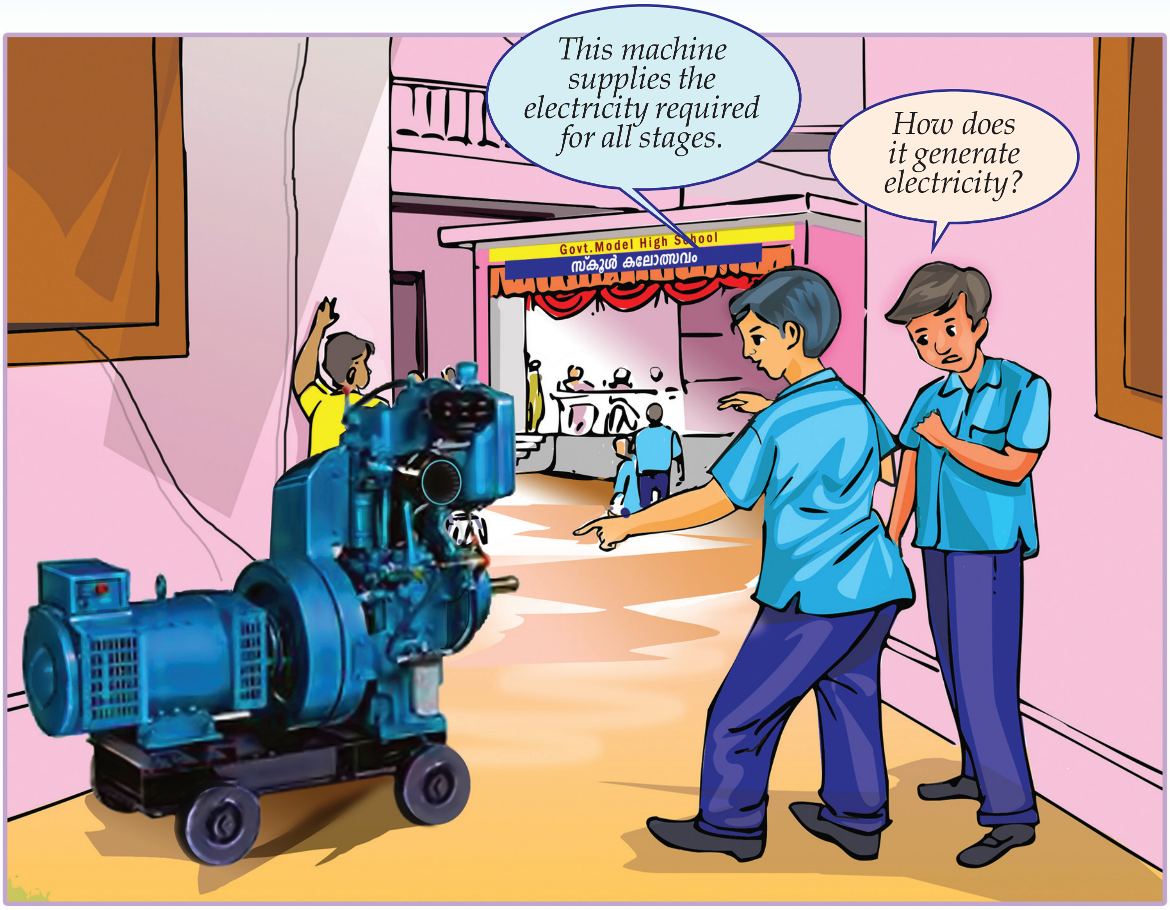
1. What are the reasons of using nichrome as a heating coil? What are the component elements of nichrome?
2. What are the points to be remembered when fuse wire is connected in a circuit? Explain.
3. An electric heater of power 920 W is working on a 230 V supply. If current flows for 5 minutes through it, calculate the heat generated.
4. How do discharge lamps produce light?
5. The marking on an electrical appliance is 800 W, 200 V.
   (a) If it works on 100 V, what is the power consumed?
   (b) What is the power when it works on 50 V?
   (c) What happens if 500 V is applied to it?

6. A potential difference of 200 V is applied to a 200 Ω resistor for 5 minutes.
   (a) Calculate the amount of heat generated.
   (b) If 200 Ω is replaced by 100 Ω, how much heat will be generated in 5 minutes?
   (c) If 400 Ω resistance is used in this place for 5 minutes, how much heat is generated?

Extended activities

1. Explain the working of a microwave oven.
2. Explain the instances when arc lamps are used in rescue operations.

3 Electromagnetic Induction



Can you clear the doubt Babu raised?

You have studied that a current that flows in a circuit can generate a magnetic field. Can you generate electricity using a magnetic field?

Let's find out by performing an experiment.

Materials required

- Bar magnet
- Solenoid made of insulated copper wire
- Galvanometer

The above materials are arranged as shown in the figure. The magnet is inserted into the solenoid and pulled out successively. The deflection of the needle of the galvanometer is noted each time.

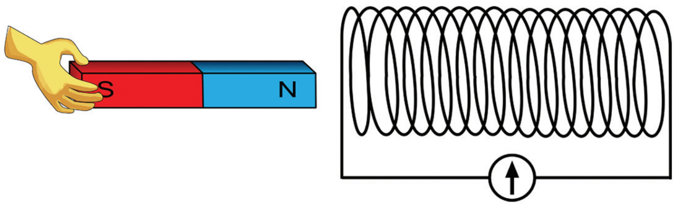


Fig. 3.1 (a)

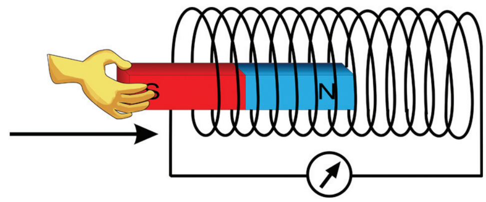


Fig. 3.1 (b)

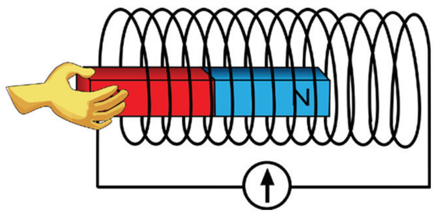


Fig. 3.1 (c)

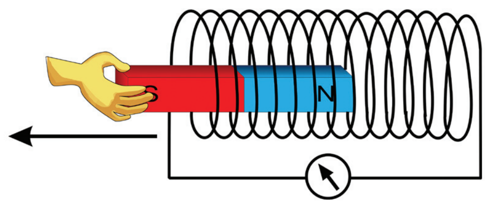


Fig. 3.1 (d)

Record your observations carefully in Table 3.1

Sl. No.	Experimental procedure	Observation (Galvanometer needle)	
		Deflects more/ Deflects less/ Does not deflect	Direction To the left/ To the right
1.	Magnet is stationary near the solenoid		
2.	North pole of the magnet is moved into the solenoid		
3.	Magnet is stationary inside the solenoid		
4.	Magnet is moved out of the solenoid		
5.	The south pole of the magnet is moved into the solenoid		
6.	Magnet and solenoid are moved on the same plane in the same direction at the same speed		

Table 3.1

Using magnets of high strength, and increasing the number of turns in the solenoid, the experiment is repeated. On the basis of the experiments, complete the table 3.2.

Experiment	Deflection of the galvanometer needle	
	increases	decreases
Number of turns increased		
Number of turns decreased		
Strong magnet is used		
Magnet/solenoid moves with less speed		
Magnet/solenoid moves with greater speed		

Table 3.2

Analyse the table and write down your inferences.

- When the magnet moves towards the solenoid, there is a flow of electric current
- When the number of turns increases, current increases
-

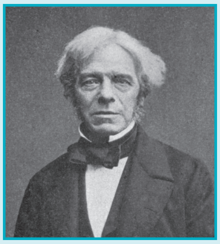
Whenever there is a relative motion between the magnet and the solenoid, there is flow of electricity. We have understood this from experiments. Have you thought about what happens when the magnet is brought near the solenoid or moved away from the solenoid?

When the magnet is brought closer to the solenoid, the magnetic flux linked with the solenoid increases. When the magnet is taken away, this decreases.

Whenever there is a change in the magnetic flux linked with the coil, electricity is induced in the coil. This phenomenon is electromagnetic induction. The current thus induced is the induced current. The voltage induced is the induced **emf**.

The famous British physicist John Ambrose Fleming discovered the law regarding the direction of induced electric current, when a conductor is moved in a magnetic field.

Michael Faraday



(1791-1867)

Faraday, an illustrious scientist in the fields of Physics and Chemistry, made his first invention in 1821. He showed that a current carrying conductor, kept in a magnetic field, can move. As a result of a series of experiments conducted by him in 1831, he could generate electricity from a magnetic field. He is known as the father of electricity. He made valuable contributions to chemistry also. But Faraday was not fortunate enough to get formal education.

Fleming's right hand rule

> *Stretch the forefinger, middle finger and the thumb of the right hand in mutually perpendicular directions. If the fore finger represents the direction of the magnetic field, and the thumb represents the direction of motion of the conductor, then, the middle finger represents the direction of the induced* current.

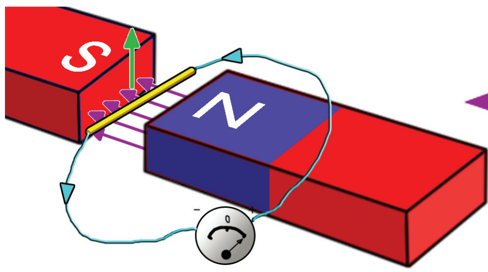


Fig. 3.2 (a)

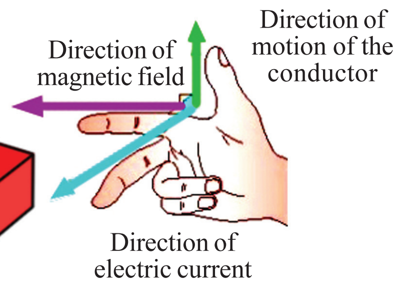


Fig. 3.2 (b)

The resistance is connected to avoid excessive current flow in the galvanometer

Let's see how the current induced in a conductor from a magnetic field differs from the current obtained from a battery.

Alternating current (AC) and direct current (DC)

A cell that can be used in a torch or a clock is connected in series with a resistor and a galvanometer. Note the direction of deflection of the needle of the galvanometer. Tabulate your observations.

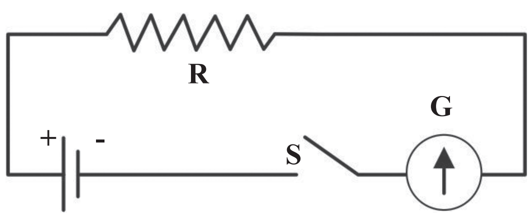


Fig. 3.3

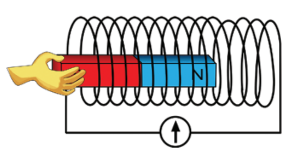
Activity	Deflection of the galvanometer
Activity 1 The galvanometer, cell, resistor, and switch are connected in series. Circuit is switched on.	
Activity 2 The galvanometer is connected to a solenoid. A magnet is moved in and out continuously in the solenoid. 	

Table 3.3

In the first activity we find that the needle of the galvanometer deflects only in one direction. What about the second activity?

What has caused the deflection of the galvanometer needle? Since the needle has deflected only in one direction in the first case, we conclude that current flowed only in one direction.

A current that flows only in one direction continuously is a direct current (DC). If the direction of current changes at regular intervals of time, it is an alternating current (AC).

By the to and fro motion of the magnet or coil continuously AC is produced. We will now see how this is done.

AC generator

Observe the figure of an AC generator.

A generator is a device which converts mechanical energy to electrical energy.

The structure of a generator can be understood with the help of Fig 3.4 (a).

Parts of AC generator

Field magnet

The magnet that creates magnetic flux in the generator

Armature

An arrangement of insulated conducting wire wound on a soft iron core

Slip rings

Metal rings which are welded together with the armature coil. They rotate along with the armature on the same axis of rotation as the armature

Brushes

They are arrangements which always make contact with the slip rings. Current flows to the external circuits through them.

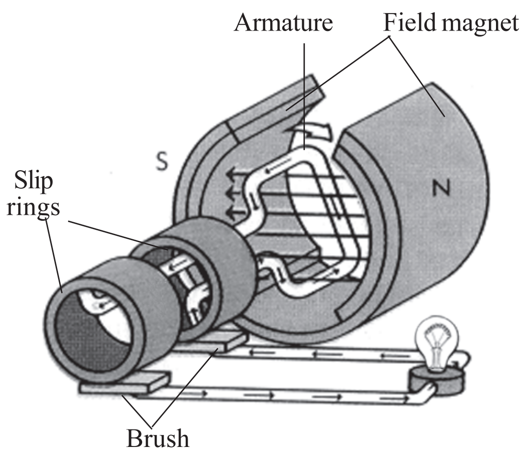


Fig. 3.4 (a)

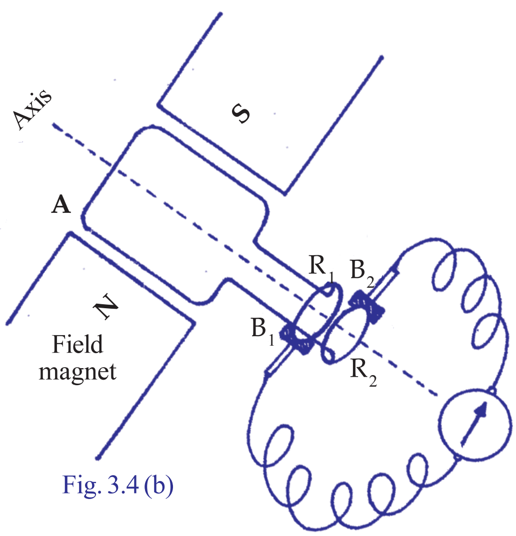


Fig. 3.4 (b)

Observe Fig 3.4 (a) and write down the parts given in Fig. 3.4(b)

A ....

B_1, B_2 ....

R_1, R_2 ....

When the armature rotates on its axis in the magnetic field, the magnetic flux linked with the coil changes. As a result, current is induced in the coil.

- When the armature rotates, will the rate of change of the magnetic flux linked with the coil, be the same always?
- What will be the nature of the induced current?

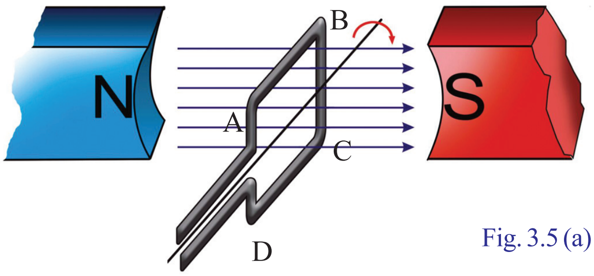


Fig. 3.5 (a)

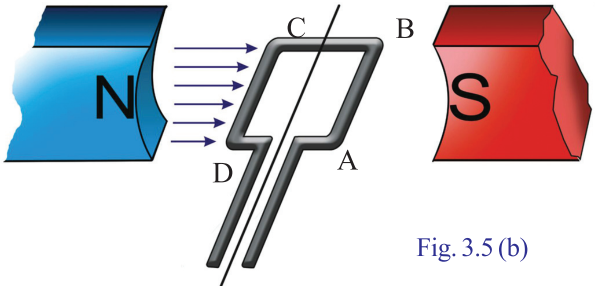


Fig. 3.5 (b)

During the interval in which the armature completes one rotation, two orientations of the coil are shown in Fig. 3.5 (a) and Fig 3.5 (b)

To understand the nature of the induced current, let's mark the armature coil as ABCD.

Observe the figures 3.5 (a) and 3.5 (b) and find the orientations at which the rate of change of magnetic flux linked with the coil reaches the maximum.

When the plane of the armature coil ABCD is perpendicular to the direction of the magnetic field, the flux linked with the coil is maximum, but the rate of change of flux is zero. Induced emf in the coil is zero. When the coil rotates through an angle 90^0 and comes in the orientation as in Fig 3.5 (b), the plane of the coil is parallel to the magnetic field. The flux linked with the coil is zero. The rate of change of flux is maximum. The induced *emf* also becomes maximum.

When the armature continues to rotate further in the same direction, the rate of change of flux decreases. The induced emf decreases and reaches a value of zero at an angle of rotation 180^o.

Find out the emf produced in the other stages of rotation.

The various stages of rotation of an armature coil while completing one rotation in a magnetic field and the graph of the emf produced by the coil are shown in Fig. 3.6.

Analyse the graph and complete the table 3.6.

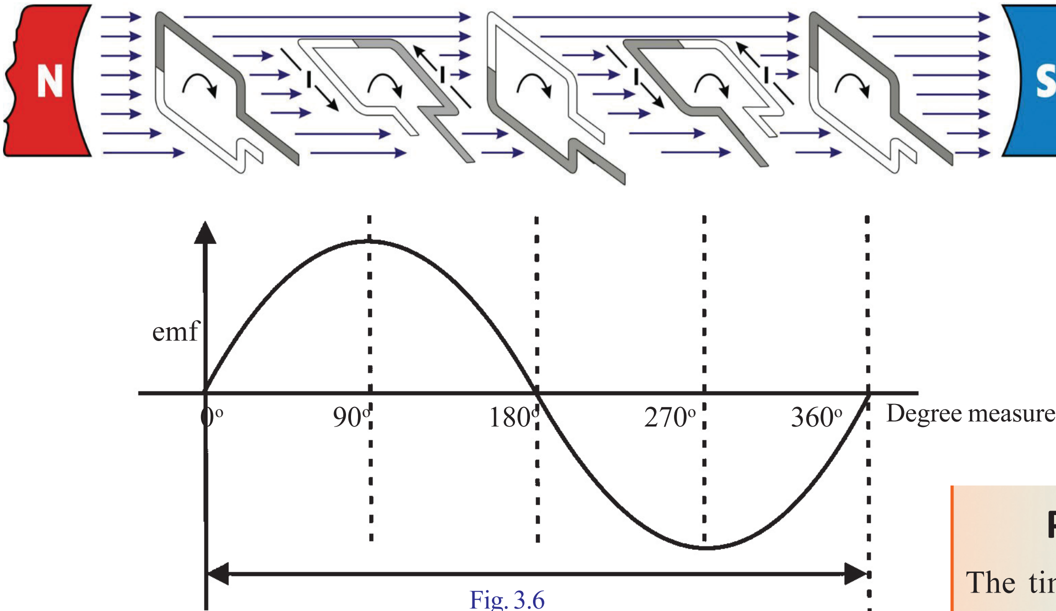


Fig. 3.6

	Time				
	0	T/4	T/2	¾ T	T
Angle of rotation	0°	90°	180°	270°	360°
Rate of change of flux	0	Maximum	0	......	......
Induced emf in volts	0	Maximum	0	......	......

Table 3.4

In an AC generator, the induced emf generated in the first half rotation in one direction and that generated in the second half rotation in the opposite direction together forms the cycle of AC. The number of cycles per second is the frequency of AC.

The frequency of AC generated for distribution in our country is 50 cycles per second or 50 Hz.

- If the frequency of AC is to be 50 Hz, the armature coil is to rotate fifty times per second, isn't it?

In order to overcome practical difficulties, the number of rotations is reduced by increasing the number of armature coils and the number of pole pieces of the field magnet in a generator.

Period T

The time taken by the armature coil for a full rotation is called the period, T. Time taken for half the rotation (180°) rotation is $\frac{T}{2}$.

- When 50 Hz AC is used, how many times will the direction of current change in the circuit?

Have you understood how the generator near the stage produced electricity?

Let's now examine the structure and working of generators that produce electricity on a large scale.

Power generator

Power stations are centres that generate and distribute large quantities of electricity.

The generators used here are called power generators. Power generators have the same structure as AC generators. What are the parts of an AC generator?

- Field magnet
-

In an AC generator, electricity is generated when the armature rotates in a magnetic field.

Let's see how electricity is generated in a power generator.

You know that when the number of turns in an armature is increased, current generated also increases. The weight of the armature also increases while increasing the number of turns.

The rotating part of the generator is the rotor and the static part is the stator.

- In a power generator, armature is used as the stator. Why?

  -

When the armature is used as the stator, the graphite brush can be avoided, thereby avoiding sparks.

- Which part of the power generator is used as the rotor?

  -

- From where is the electricity obtained for the working of the field magnet in a power generator?

  -

- In a power generator, strong electromagnets are more suitable as field magnets than permanent magnets. Write down the reasons.

- Strength of a permanent magnet decreases gradually. Hence the magnetic flux cannot be maintained.
-

Single phase generator, three phase generator

In the generator shown in Fig. 3.4 (a) there is only one set of coils in between the pole pieces of the field magnet. Such generators are single phase generators. For the production of electricity on a large scale, three phase generators are used. See the structure of a three phase generator Fig. 3.7 (a).

In power generators, three armature coils are arranged around the field magnet at an angular separation of 120°. When the field magnet rotates, three alternating currents of different phases are generated simultaneously in all the three armatures. In each armature, maximum and minimum *emf*s are generated at different instances. Such generators are three phase generators. Observe Fig. 3.7 (a) and 3.7 (b) and identify the correct statements from the following.

- For each field magnet, there is only one armature.
- There are three sets of armature for each field magnet.
- The number of turns in each armature coil is the same.
- The maximum and the minimum value of the induced *emf* are the same in all the three armature coils.
- In the three phase generator, field magnets are permanent magnets.
- The frequency of AC is the same in all the three armature coils.

Exciter

In a power generator, electromagnets are used as field magnets. DC is used for these electromagnets. An auxiliary generator used for this is called an exciter. In modern generators, big batteries are used instead of exciters.

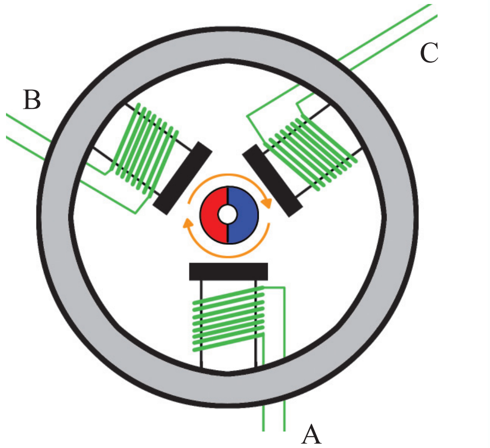
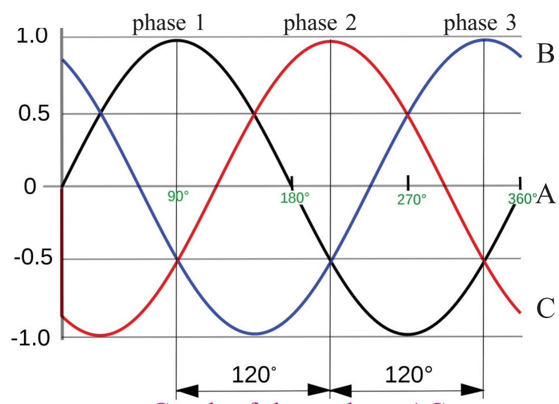


Fig. 3.7 (a)



Graph of three phase AC

Fig. 3.7 (b)

- AC generated in all the three armature coils will be of the same phase in the same time.
- AC generated in all the three armature coils will be of different phases at the same time.

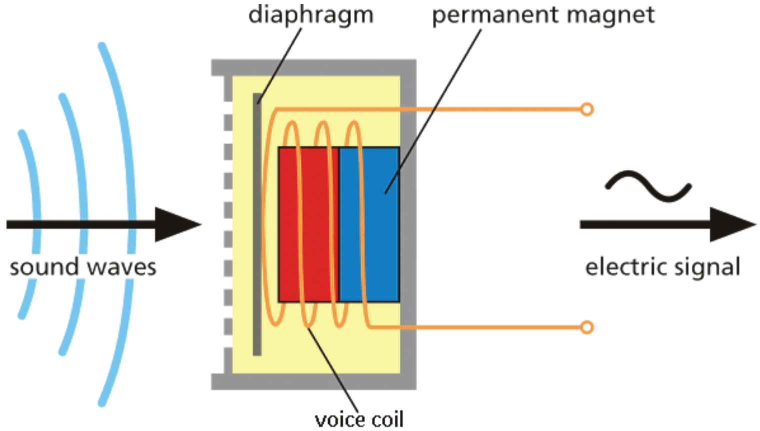
List other familiar devices which work on electromagnetic induction.

- Moving coil microphone
-

You are familiar with microphones. Let's see how they work.

Moving coil microphone

Analyse Fig. 3.8 and find answers for the following questions.



Moving coil microphone
Fig. 3.8

- Which are the important parts of a moving coil microphone?

- -

- Which is the moving part in it?

- -

- If a sound is produced in front of a movable diaphragm, what happens to the diaphragm?

- -

- What happens to the voice coil?

- -

- What is the result?

- -

Working of a moving coil microphone

The voice coil is situated in a magnetic field. The diaphragm connected to the voice coil vibrates in accordance with the sound waves falling on it. As a result, electric signals corresponding to the sound waves are generated. In the microphone, mechanical energy is converted into electrical energy.

When a sound is produced in front of a microphone, electric signals in accordance with the sound is generated in the coil.

The weak signals obtained from the microphone are strengthened by an amplifier.

What is the energy transformation in a moving coil microphone?

There are microphones working on different principles. Moving coil microphone is one among them.

By the principle of electromagnetic induction, is it possible to produce an electrical current in a circuit using the electrical energy in another circuit?

Mutual induction

As shown in Fig. 3.9, a few turns of finely insulated copper wire are wound at each end of a soft iron core (approx. 500 turns). The ends of one of the insulated copper wire are connected to a cell and a switch. The insulated copper wire which is wound on the other end of the soft iron rod is connected to a bulb.

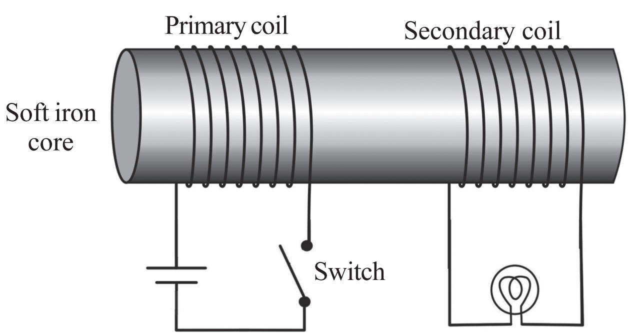


Fig. 3.9

- What do you observe, if you turn the switch on and off continuously?
- If the switch is kept on, what do you observe?
- When is magnetic flux formed?
- When does the flux change?

Different types of microphones

In addition to moving coil microphones, four more types of microphones are in use.

1. **Carbon microphones**

   The main part of this is a small box called button containing carbon granules. A thin metal disc called the diaphragm presses against the button. The diaphragm vibrates in accordance with the sound waves and corresponding electrical variations are produced. Carbon microphones are mainly employed in telephones.

2. **Crystal and ceramic microphones**

   The main part of this type of microphone is piezoelectric crystals. Piezoelectric crystals can generate electricity when they are subjected to pressure. In ham radios, crystal and ceramic microphones are used.

3. **Ribbon microphones**

   The main part is a metallic ribbon suspended in a magnetic field. When sound waves fall on the metal ribbon, the ribbon vibrates accordingly inside the magnetic field. The vibration of the ribbon in the magnetic field produces flow of electricity.

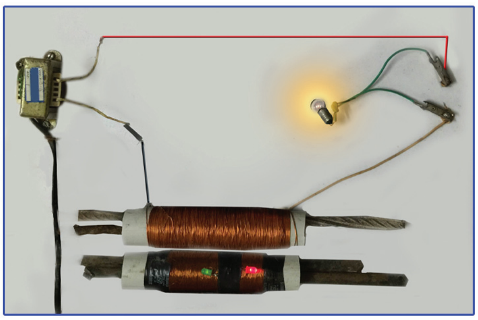
4. **Capacitor microphones**

   They are also known as condenser microphones. The main part of it is two thin metal discs arranged side by side. The flexible plate in the front works as a diaphragm. The plate at the back is not capable of motion. Sound waves vibrate the front plate. This causes a change in the current through the capacitor. This type of microphone is used in hearing aids.

- When does the current flow in the other coil?
- Which coil has given current for the production of the magnetic field?
- In which coil is induced *emf* generated?
- What is the name of the coil to which current is given? What about the coil in which current is generated?

The coil to which we give current for the production of magnetic field is the primary coil and the coil in which induced emf *is generated is the secondary coil.*

Can you suggest a method for producing flux changes without switching on and switching off the circuit continuously? Let's perform an activity.



Mutual induction
Fig. 3.10 (a)

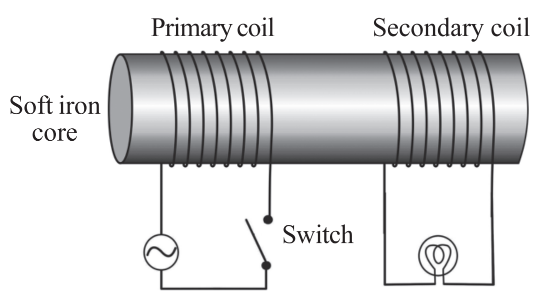


Fig. 3.10 (b)

Look at the Fig. 3.10 (b). Connect a 6 V AC source into a primary coil and turn on the switch. What do you observe?

- The bulb glows continuously. Discuss the reason for this and write it down in the science diary.

The experiment is repeated by increasing and decreasing the number of turns of the coil in the secondary, as compared to that in the primary. Write down your observations in table 3.7.

Activity	Observation
Increase the number of turns in the secondary than that in the primary	
Decrease the number of turns in the secondary than that in the primary	

Table 3.5

When an AC passes through the primary, a varying magnetic field is formed in and around the soft iron core. The secondary is situated in this varying magnetic field. This situation is similar to the moving of a magnet inside the secondary coil. The flux change produced in the secondary coil induces an emf in it. This phenomenon is the mutual induction.

Consider two coils of wire kept side by side. When the strength or direction of the current in one coil changes, the magnetic flux around it changes. As a result, an emf is induced in the secondary coil. This phenomenon is the mutual induction.

A transformer is a device that works on the principle of mutual induction.

Let's see how a transformer works.

Transformer

Transformer is a device for increasing or decreasing the voltage of an AC without any change in the electric power. Transformers are of two types.

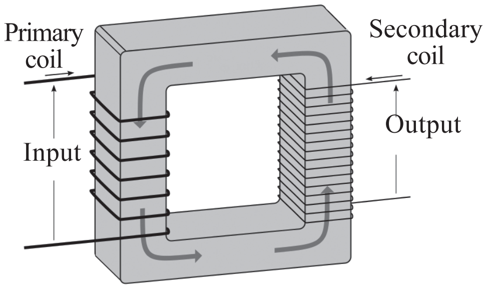
The AC voltage is increased by a step up transformer.

The AC voltage is reduced by a step down transformer.

Examine the diagrams of step up and step down transformers and list out the differences in their designs.

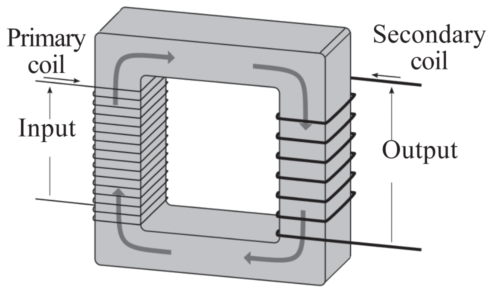
Induced *emf*

In a transformer, the AC applied to the primary coil produces a varying magnetic field. This produces an induced emf in the primary. The change of flux in the primary coil is linked with the secondary. Hence an emf is induced in the secondary coil also. Thus the emf induced in each turn of the primary and secondary will be the same.



Step up transformer

Fig. 3.11 (a)



Step down transformer

Fig. 3.11 (b)

Step up transformer	Step down transformer
• Thick wires are used in the Primary	
•	

Table 3.6

As the number of turns in the secondary increases, the induced emf also increases.

The emf in each turn of the primary coil and each turn of the secondary coil will be the same. Let the emf in one turn be e. Then, the emf in the primary is $V_p = N_p \times e$

Where Np is the number of turns in the primary the induced emf in the secondary is

$V_s = N_s \times e$

Hence, V_s changes in accordance with the number of turns in the secondary. The voltage in the secondary and primary will be in the same proportion as the number of turns of the secondary and primary.

That is $\frac{V_s}{V_p} = \frac{N_s}{N_p}$. This is the relation connecting voltage in the primary and secondary coils, and the number of turns in the primary and secondary coil of a transformer.

Making use of this equation, complete the following table.

Primary coil		Secondary coil	
Number of turns N_P	Voltage V_P	Number of turns N_S	Voltage V_S
500	10 V	2500	....
....	100 V	800	25 V
600	....	1800	120 V
12000	240 V	....	12 V

Table 3.7

- A transformer working on a 240 V AC supplies a voltage of 8 V to an electric bell. The number of turns in the primary coil is 4800. Calculate the number of turns in the secondary coil.

- The input voltage of a transformer is 240 V AC. There are 80 turns in the secondary coil and 800 turns in the primary. What is the output voltage of the transformer?

The power in the primary and secondary coils of a transformer is the same.

If there is no loss of power from a transformer, the power in the primary and in the secondary are equal.

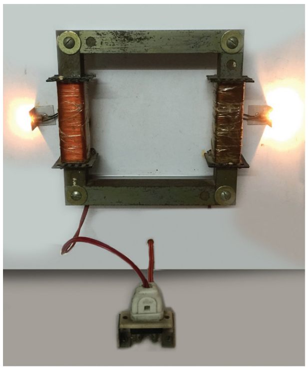
- If voltage and current are known, what is the formula for finding power?

  Power = Voltage × Current

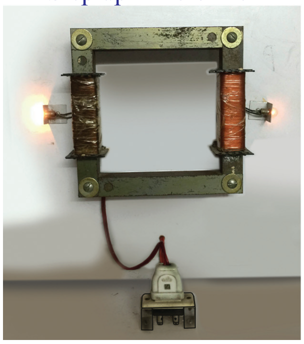
- In a transformer, if the voltage of the primary is V_P and current in the primary is I_P, voltage in the secondary is V_s and current I_s, write down the formulae connecting them.

  Power in the primary = ... × ....

  Power in the secondary = ... × ....



Step up transformer



Step down transformer

In a transformer,

Power in the primary = Power in the secondary

That is ,

$$V_P \times I_P = V_S \times I_S$$

$$\therefore \frac{I_p}{I_s} = \frac{V_s}{V_p}$$

$V_p \times I_p = V_s \times I_s$. In a step up transformer the voltage in the secondary coil is more and the current is less. But in a step down transformer the secondary voltage is less and the current is more.

- In a transformer without any loss in power, there are 5000 turns in the primary and 250 turns in the secondary. The primary voltage is 120 V and the primary current is 0.1 A. Find the voltage and current in the secondary.

Categorise the following relations appropriately under step up or step down transformers in the following table.

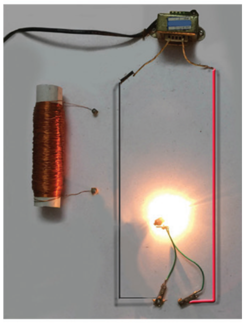
- $V_s > V_p$
- $V_s < V_p$
- $I_s < I_p$
- $I_s > I_p$
- $\frac{N_s}{N_p} < 1$
- $\frac{N_s}{N_p} > 1$

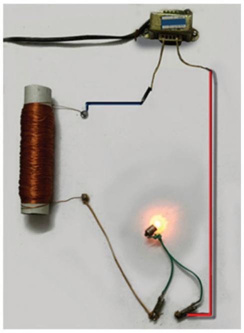
Step up transformer	Step down transformer
• $V_s > V_p$	• $V_s < V_p$

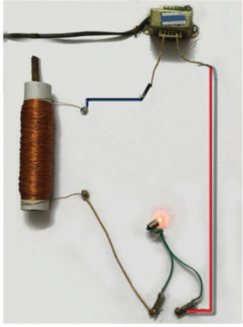
Table 3.8

As a result of the flow of an alternating current through a solenoid, is there any chance of inducing an electric current in the solenoid? Let's examine.

Self Induction


6 V AC connected to the bulb directly


6 V AC connected to the bulb through a solenoid


Softiron core in a solenoid

Take two insulated copper wires about a length of 3 m and of the same diameter. One wire is connected to a bulb and a 6 V battery as shown in Fig. 3.12 (a).

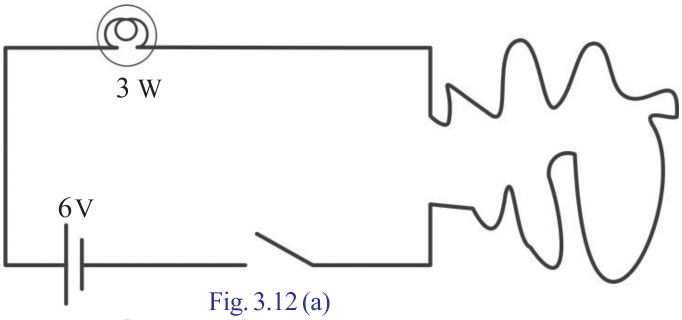


Fig. 3.12 (a)

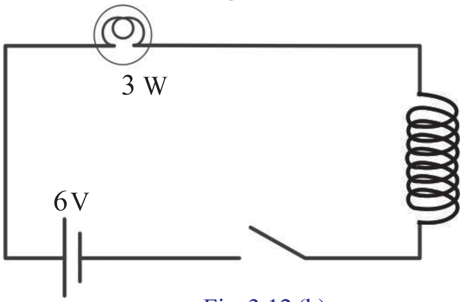


Fig. 3.12 (b)

Switch on the circuit and observe the intensity of light emitted by the bulb. The second wire is wound as a coil and it is connected to a bulb and the 6 V battery as shown in Fig 3.12 (b). Turn the switch on and observe the intensity of light emitted.

In both the circuits use 6 V AC instead of 6 V DC.

Do you observe any change in the intensity of light?

What is the reason? Let's examine.

When an AC passes through a solenoid, a changing magnetic field is generated around it. Due to this an induced emf is generated inside the solenoid. This induced emf is in a direction opposite to that applied on the coil. Hence this is a back emf. This back emf reduces the effective voltage in the circuit.

The change in magnetic flux due to the flow of an AC in a solenoid will generate a back emf in the same solenoid in a direction opposite to that applied to it. This phenomenon is the self induction.

Repeat the same experiment using AC, keeping a softiron piece in the solenoid.

- What is the change in the intensity of light?
- The permeability of soft iron is high. What may be the reason for the decrease in the intensity of light?
- When the core of the coil is of soft iron, what happens to the magnetic flux linked with the coil?
- When the soft iron core is removed from the coil, what is the change in the intensity of light from the bulb?

When the soft iron core is inside the coil, the magnetic flux linked with the coil increases. As a result, the back emf increases. So, the effective voltage decreases. When the soft iron core is removed, the back emf decreases.

Inductors

An inductor is an insulated copper wire wound in a helical shape.

Inductors are coils used to oppose the changes in electric current in a circuit. They are used to reduce current in a circuit to the desired value without loss of power.

- Inductors are widely used in AC circuits. What is its necessity?
- If resistors are used instead of inductors, what is the disadvantage?
- Inductors are not used in DC circuits. Find out the reason and write it down in the science diary.

The use of AC is increasing every day. From where do we get the energy necessary for the production of electricity?

More facts about power generation will be discussed later.

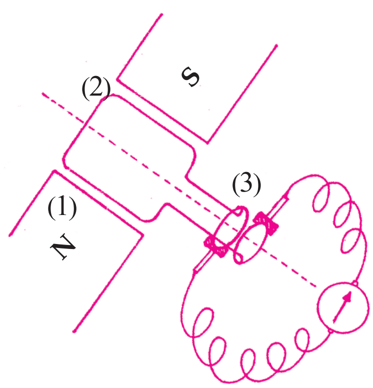
Significant Learning Outcomes

The learner can

- explain the phenomenon of electromagnetic induction with the help of experiments, and suggest methods to increase induced emf.
- find the direction of induced current in a conductor using Fleming's Right Hand Rule.
- explain the construction and working of an AC generator.
- compare the structure and working of single phase and three phase generators, with the help of diagrams and explain them.
- explain the working of a microphone based on the principle of electromagnetic induction.
- explain with the help of a diagram, the structure, principle and working of a transformer.
- explain self induction and the instances of its usage.

Let us assess

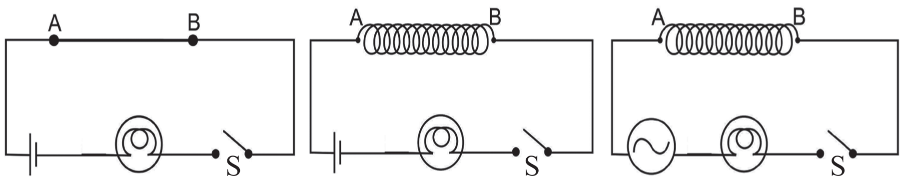
1.



(a) Write down the name of parts numbered in the diagram.

(b) State the working principle of this device.

2. Copper wires of the same length and thickness are connected to points A and B in all the three circuits. In circuit (a) copper wire is not coiled. In circuits (b) and (c), the copper wire is coiled. Observe the circuits and answer the following questions.



(a) (b) (c)

(a) When circuit (a) is switched on, what do you observe?

(b) When circuit (b) is switched on, what change do you observe in the intensity of light? Justify your answer.

(c) When circuit (c) is switched on, what change do you observe in the intensity of light? Justify your answer.

3. The current in the secondary coil of a transformer is 1 A and that in the primary is 0.5 A.

(a) What type of a transformer is this?

(b) If 200 V is available in the secondary coil of this transformer, what is the voltage in the primary?

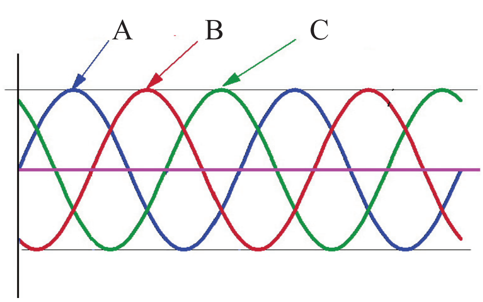
(c) Explain the working principle of a transformer.

4. In connection with the working of a microphone, a few statements are given in boxes.

Arrange them in the proper order.

voice coil vibrates → diaphragm vibrates → Electrical signals are produced in the voice coil ↓ Sound is produced

5. Given below is a graph of the output from the secondary coil of a transformer. Observe the graph and answer the following questions.



(a) The electricity produced from which type of generator does the given graph represent?

(b) The maximum and minimum voltages in A,B,C are the same. Give the reason.

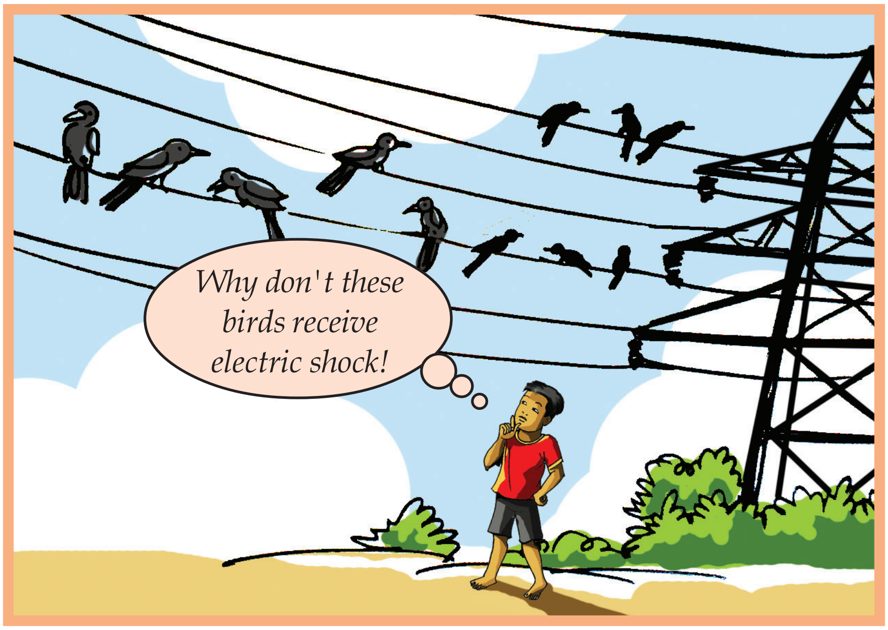
6. Thick insulated copper wires are used in the primary coil of a step up transformer and in the secondary of a step down transformer. What is the necessity of doing this? Why is it so?

Extended activities

1. Make coils of different number of turns using insulated copper wire. Use magnets of different strengths to produce induced emf. Present this activity in the science club.
2. Michael Faraday, the father of electricity, did not even get elementary education. Are you not inspired by the achievements of Faraday in the field of science?

   Conduct a seminar on *"Contributions of Faraday and the hard work behind it."*
3. Energy is invaluable, especially electrical energy. Society must be convinced of the necessity of reducing the consumption of electrical energy. Prepare and propagate posters for this purpose.
4. Collect information regarding microphones which work under different physical principles.
5. Compare the induced current obtained when the armature coil rotates once in between the poles of a magnet, and the induced current obtained when the experiment using a magnet and coil was performed.

4 Power Transmission and Distribution



You know that there is electricity in electric lines. Where does this electricity come from?

You have studied that electricity is obtained from a generator. What is the energy conversion that takes place in an AC generator? What are the sources from which the energy required to work a generator is made available? Power generating centres have been established at different places, depending on the availability of energy. Power stations are centres generating large amounts of energy for the purpose of distribution.

In our country, which are the stations that generate electricity on a large scale?

- Moolamattom hydroelectric power station
-

In houses and shops, electricity is produced using generators. But we don't consider them as power stations.

The mechanical energy required for running power generators is made available in different ways. Power stations can be classified on the basis of the sources of energy required to operate the generator.

- Flowing water → hydroelectric power stations
-

Hydroelectric power station

- Water stored at a height is allowed to flow down through a penstock pipe. The energy of the flowing water is used to rotate the turbine and generate electricity.
- Such power stations are established at Pallivasal, Moolamattom, etc., in Kerala.
- The energy change taking place here is : Potential energy → Kinetic energy → Mechanical energy → electrical energy.

Thermal power station

- Fuels like coal, naphtha, lignite, etc., are ignited. The heat energy liberated is used to convert water into steam at high temperature and pressure.
- The energy of steam is used to rotate the turbines to generate electricity.
- Such power stations are established at Neyveli, Kayamkulam, etc.
- The energy change taking place here is: Chemical energy→ Heat energy → Mechanical energy → Electrical energy.

Nuclear power station

- Water is converted to steam at a high temperature and pressure using nuclear energy.
- The force of steam is used to turn the turbines to generate electrical energy.
- Such power stations are established at Tarapur, Kalpakkam, Kota, Koodamkulam, etc.
- Energy change taking place here is : Nuclear energy → Heat energy→ Mechanical energy →Electrical energy.

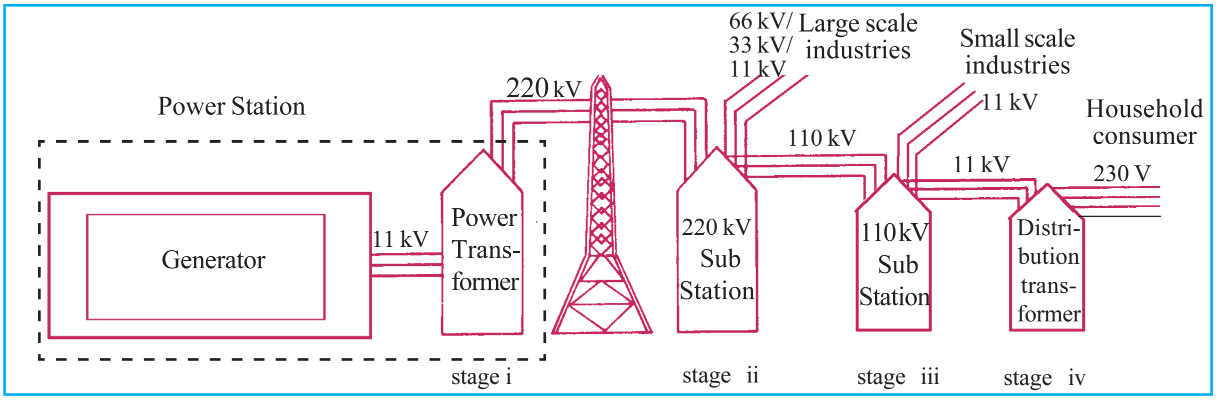
On the basis of reading notes and discussions, complete table 4.1.

Power station		Energy change
Hydro electric power station	• Moolamattom • Kuttiadi • Pallivasal •	
Thermal power station	• Neyveli • Kayamkulam • Ramagundam •	
Nuclear power station	• Tharapur • Kalpakkam • Kota •	

Table 4.1

Power transmission and transmission loss

Power transmission is the process of sending electricity to distant places through wires from the power station. The conducting wires used for this purpose are the transmission lines. The various stages of power transmission and distribution are shown schematically in the following diagram.



Different stages of electric power transmission

Fig. 4.1

Observe the diagram and answer the following questions.

- In which stage of power transmission is the step up transformer used?
- What is the voltage at which electricity is generated at the power station?
- Which are the stages in which step down transformers are used in power transmission?
- What is the voltage of electricity supplied for domestic consumption?

In our country, electricity is generated at 11 kV. Electricity is supplied to household users at 230 V. Still at the generating station itself, a power transformer is used to step up the voltage from 11 kV to a higher voltage of 220 kV. Have you thought about the necessity of this stepping up?

What are the problems faced when electrical power is to be transmitted to distant places?

- Voltage drop
-

Voltage drop and power loss are the problems we encountered edwhen power is transmitted to distant places.

When electricity passes through a conducting wire energy is lost in the transmission lines in the form of heat. This energy loss has to be reduced to a minimum when power is transmitted to long distances. How can we do this?

Write down your inferences employing Joule's law

- Reduce the resistance of transmission lines
- Reduce the strength of current in the transmission lines

How can the resistance be reduced?

The resistance can be reduced by increasing the thickness of the conducting wires. But this will increase the weight of the transmission lines and thick pillars will be required to support them. This will increase the cost of establishing the lines and will present technical difficulties.

- If the strength of the current is reduced, what change will occur in electric power? Find out the change on the basis of the equation P = V1
- How can we reduce current without power loss?

  We know that the power P = Vx I
- If voltage is increased tenfold, what will happen to the current?

What about the heat generated? In the light of Joule's Law ($H = I^2Rt$) write down your inferences. When the voltage increases 10 times, the current will be reduced by $\frac{1}{10}$. Then, according to Joule's Law, won't the heat generated be reduced by $\frac{1}{100}$. Isn't transmission at a high voltage is advantageous then?

Transmission of electricity to distant places is done at a high voltage. This will reduce the problems of transmission to some extent.

Power grid

If the working of a power station comes to a standstill, the places under its limits will not get electricity. How can this problem be solved?

The electric power generating centres are located at different places.

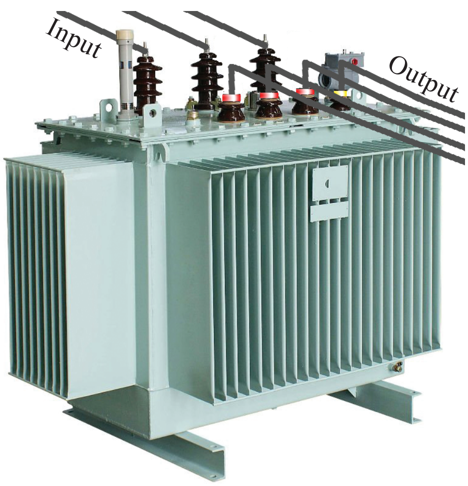
The different power generating centres and distribution systems are connected by a network. This network is the power grid.

Because of this arrangement, if defect occurs either at the generator or transmission lines, electricity can be taken from any other power generating centre through another set of transmission lines.

Power distribution

A transformer in the power distribution system erected for the purpose of household distribution is shown in Fig 4.2.

Observe the diagram and find the answers to the questions.



Distribution transformer
Fig. 4.2

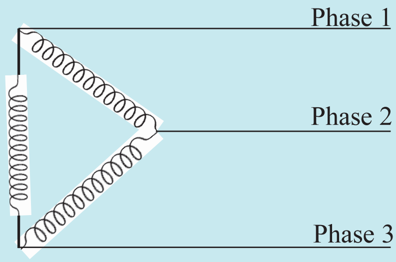
- How many lines reach the distribution transformer?
- How many lines go out of the distribution transformer?

Power cut and load shedding

When the electricity produced is not sufficient to meet the requirements, power cut or load shedding will be declared. In such situations, each factory will be given only lesser quantity of electricity than is usually supplied for a period of time. This is power cut. There is a reduction in the allotted quantity of electricity. A certain percentage of the allotted electricity is cut off. When the required quantity of electricity cannot be generated, all consumers cannot be given electricity as in normal conditions. In this situation, available electricity is distributed judiciously. Supply of electricity to certain places will therefore, be stopped for a specified period. At that time, other places will get electricity. This is load shedding.

Depending on the consumption of energy the working of the generator can be controlled by regulating the flow of water into it. So when we turn off a switch, the water thus saved is preserved in the dam.

Delta connection



If the coils are connected as shown in the figure, it is a delta connection. When coils are connected in this way, there is no neutral point.

In the generators of the power station, the coils will be in star winding. But in the subsequent stages, they are connected in delta connection. In the distribution transformer, the output will be in star winding.

In large and small scale industries, the primary and the secondary coils are in delta winding.

In star connection, it will be possible to make available 230 V and 400 V.

In almost all motors, delta connection is needed. Delta connection is desirable for transmission to distant places because only three lines are required here. There is no neutral in the delta connection. Four wires are required for star connection.

Why is it necessary to make such an arrangement?

Star connection

The method of connecting the secondary coils of a distribution transformer is shown in Fig.4.3.

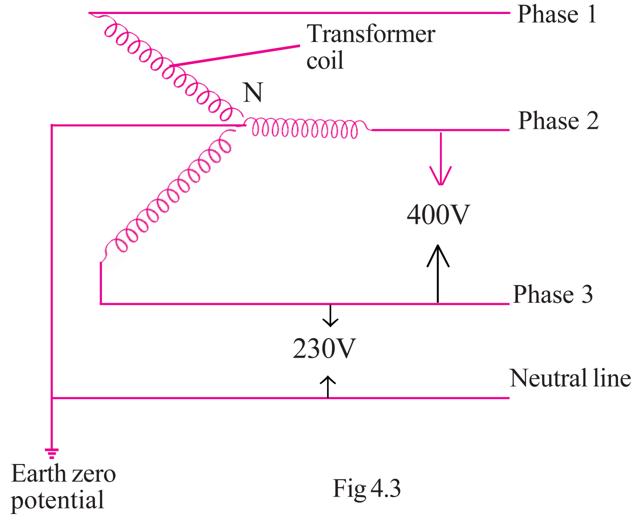


Fig 4.3

This method of connection is the star connection. Analyse the diagram and find out the answers to the following questions and write them down in the science diary.

- What is the potential of the point where all the 3 phase lines are connected together?
- What is the name of the line starting from the common point?
- What is the potential difference between 2 phase lines?
- What is the potential difference between the earth and the neutral line?
- What is the potential difference between any one phase line and the neutral line?

The potential difference between any phase line and the earth in a household distribution transformer is 230 V.

Can you light a bulb using one phase line alone?

You know that a potential difference is required for the flow of an electric current.

When a single line is touched, no potential difference is felt. It may now be clear why birds seated on an electric line do not get electrocuted.

Distribution of electricity for household purposes is done by using one phase line and neutral. But the distribution for industrial purpose is done using the three phase lines. What is the advantage of this?

Let's see how household electrification is done.

Household electrification

Using identical bulbs, two circuits are made as shown in Fig. 4.4

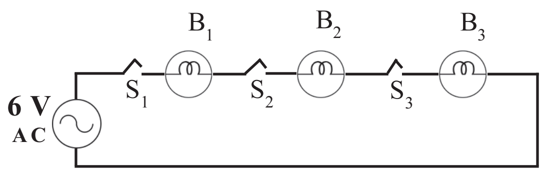


Fig. 4.4 (a)

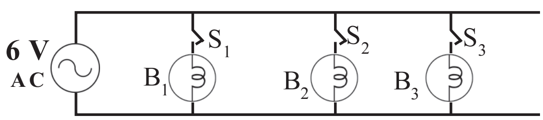


Fig. 4.4 (b)

- How are the bulbs arranged in each circuit?

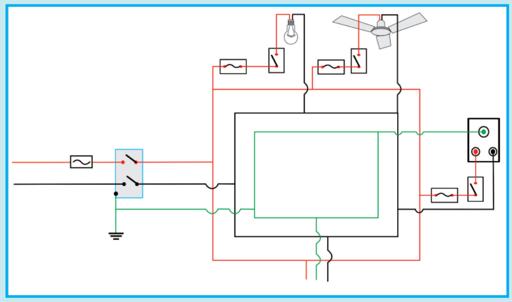
When different resistors are connected in series, the current flowing in all the resistors will be the same. When they are connected in parallel, how will be the current in each resistor?

All the switches in both the circuits may be turned on.

- In which circuit do the bulbs give brighter light? Why?
- Turn off one switch in each circuit. Note the result.
- Turn on and turn off the switches in each circuit one after the other. What do you observe?
- On the basis of experiments and observations you have made, which mode of connecting devices in your household electrical circuit is advisable?

Ring System in household wiring

Look at the figure.

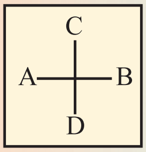


In this system, the phase line, neutral line and the earth line from the main switch are taken to all the rooms and then returned to the main switch. Each branch is tapped from this as and when necessary. This type of household electrification is the ring system.

Advantages

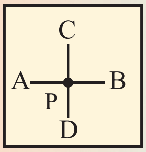
Electricity reaches every appliance through two paths. Hence the thickness of the conducting wires can be reduced. In order to include a new appliance in the circuit, a line need not be started from the main switch.

When conductors cross



(i)

In a circuit diagram, the conductors AB and CD are to be drawn as shown in Fig. (i) if they have no inter connection.



(ii)

If they are connected together at the point P, it will be as shown in Fig. (ii).

The following statements may be arranged appropriately in the table given below.

- All the bulbs burn as per the power marked on them.
- As the number of bulbs increases, the total resistance increases.
- Bulbs cannot be controlled individually using switches.
- The same voltage is available for all the bulbs.
- Bulbs can be controlled individually, using switches.
- The bulbs will get the required voltage.
- The voltage required for the bulbs will not be available.

When connected in series	When connected in parallel
• Resistance increases in proportion to the number of bulbs •	• Bulbs get brightness in proportion to the power marked. •

Table 4.2

Look at the pictorial representation of a household electric circuit (Tree system).

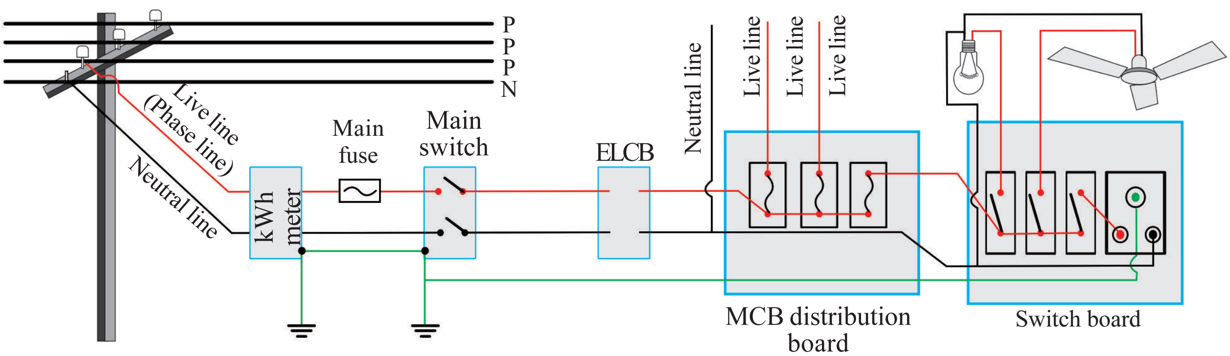


Fig 4.5

Analyse Fig.4.5 and find the answers to the questions given below.

- To which device is the electric line reaching our home connected first?

- What is the use of a watt hour meter?
- In which line is the fuse connected?

  -

- What is the function of the main switch? Where is its position in the circuit?

  -

- How are the household devices connected? Series/ parallel

In the household electrical circuit, which is the third line, other than the phase and the neutral?

Why should electrical appliances be earthed?

The instrument which is used for measuring electrical energy consumed is the watt hour meter. This is calibrated in the unit kilowatt hour (kWh).

A device of power 1000 watt (1 kW) when used for one hour consumes one unit of electrical energy (kWh)

1 unit = 1 kWh. This unit is used to calculate the consumption of energy.

Electrical energy consumed can be calculated as shown below:

Watt hour meter

Electricity reaching our house through electric lines enter the watt hour meter first. Then it passes through the main switch to different appliances. The commercial unit of consumption of electrical energy is kWh. The watt hour meter is the instrument which is used for measuring the energy consumed in kilowatt hour (kWh).

$$\text{Energy (in kWh)} = \frac{\text{Power in watt} \times \text{hours}}{1000}$$

- A grinder of power 750 W works for 2 hours. Calculate the energy consumed.

$$\text{Energy} = \frac{750 \times 2}{1000} = \frac{1500}{1000} = 1.5 \text{ unit (kWh)}$$

- In a house, 5 CF lamps each of 20 W, works for 4 hours, 4 fans each of 60 W work for 5 hours and a TV of 100 W works for 4 hours in a day. What will be the consumption shown by the watt hour meter per day?
- Complete the table 4.3

Sl. No	Appliance	Power (W)	Number	Duration of use (h)	Energy consumed (kWh)
1	C.F Lamp	20	5	4	$\frac{20\times5\times4}{1000}=\frac{400}{1000}=0.4$
2	Fan	60	4	5	
3	Television	100	1	4	

Table 4.3

Earthing for safety

The pin E of a three pin plug comes into contact with the earth line. This pin is now connected to the body of the appliance. If the body comes into contact with an electric connection, electricity flows to the earth through the earth wire. The flow of current to the earth through a circuit of low resistance increases the current. Hence heat generated in the fuse wire increases, the fuse wire melts and the circuit is broken. This will protect the instrument and the person handling it. The length and thickness of the earth pin is more than that of other pins. Since the length is more, when the three pin is introduced into the socket, the earth pin comes into contact with the circuit first. When the three pin is pulled out of the socket, the earth pin will be the last to break the contact. Hence complete safety is ensured by the three pin plug. Since thick copper wire is used as the earth wire, a path of low resistance is created. Electricity can easily flow to the earth through this path.

What are the methods for ensuring safety in the household distribution of electricity?

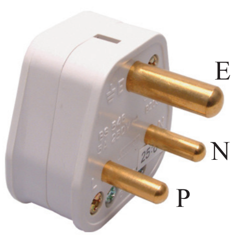
Three pin plug and safety

In order to ensure safety, three pin plugs are used in some appliances. In the figure, which are the lines that are connected to the coil of the electric iron?

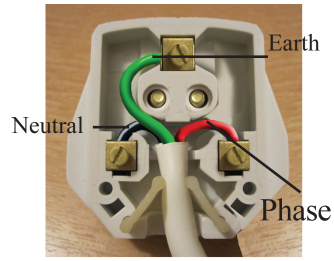
If the phase line comes into contact with the body of the appliance due to defects in the insulation, what happens to the person who touches the body of the appliance?

How can safety be ensured using a three pin plug?

Look at the figure.



Three pin plug



Inside view of a three pin plug

Fig 4.6

- Which line comes into contact with the pin E?
- How is the earth pin different from the other pins? Why is it made different in this way?
- Which part of the instrument is connected to the earth line?

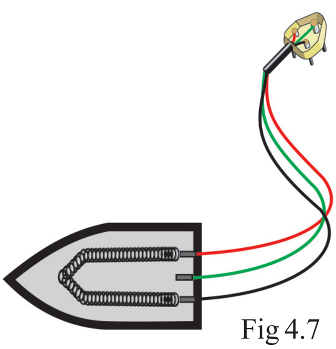


Fig 4.7

In case the metal body of the electrical appliance comes into contact with a live wire, electricity will flow to the earth through the earth pin of the three pin plug. Hence accidents due to electric shock can be avoided. Chances of getting electric shock are there if there is any laxity in the safety measures taken.

First aid to be given in the case of electric shock

As a result of electric shock, the body temperature of the victim decreases, viscosity of blood increases and clotting of blood occurs. In addition, muscles of the body contract.

First aid should be given only after disconnecting the victim from the electric wire.

How to provide the first aid:

- Raise the temperature of the body by massaging.
- Give artificial respiration.
- Massage the muscles and bring them to the original condition.
- Start first aid for the functioning of the heart (Apply pressure on the chest regularly)
- Take the person to the nearest hospital immediately.

Fig 4.8

Electricity is an integral part of everyday life. This energy is to be conserved for tomorrow and so its consumption should be reduced to the minimum possible. ***"Saving electricity is equivalent to generating electricity."*** Electricity is highly useful, at the same time it is a dangerous form of energy. Hence electrical appliances should be handled with extreme care.

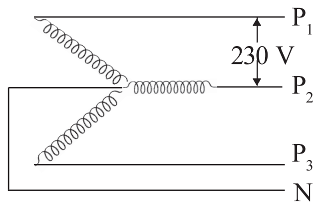
Significant Learning Outcomes

The learner can

- explain the functions of different types of power stations
- explain the reason for transmitting electricity to distant places at a high voltage.
- explain what is star connection, and how it is utilised in power distribution.
- compare the features of series and parallel connections, draw the diagram of a household circuit including various devices and calculate the energy consumption.
- explain how earthing helps to ensure safety.
- explain with the help of diagrams how safety is ensured by using three pin plugs.
- acquire information to do first aid and apply this knowledge when a person suffers an electric shock.

Let us assess

1. The figure of a star connection is shown below. Observe the figure and correct mistakes, if any, and answer the questions:



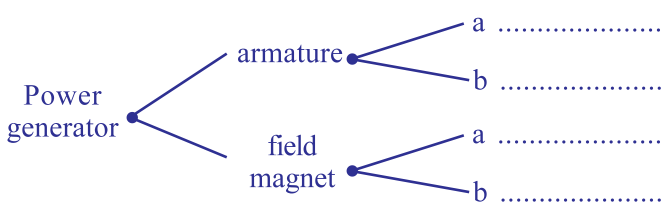
   (a) Each end of the secondary coils coming out of a distribution transformer is connected to a common point. What is the name given to the line that starts from here?

   (b) Which pairs of lines are used in household electrical wiring? What will be the voltage between them?

   (c) What is the voltage between two phase lines?

2. Using the information given in the brackets, complete the flow chart.

   (rotor, coil wound over soft iron core, electromagnet, stator)



Extended activities

1. Prepare and exhibit posters showing the need for conserving electrical energy.
2. Exhibit a model of electrical distribution network
3. Draw an electrical circuit containing the electrical appliances required for your class room
4. In order to ensure safety in electrical circuits, how can the earthing arrangement be done? Discuss and prepare a note.
5. Observe and record the meter reading in your house for 10 consecutive days. Based on this, find out the average consumption per day. Find out methods to reduce consumption and record them. Present your findings in the Energy Club.

5 Heat

Coolants receive the heat given off during the working of an engine. How is this possible?

What characteristic of coolant is made use of here?

Kinetic Theory

You know that the building blocks of all matter are molecules. Don't you?

Complete the table given below based on the freedom of molecular motion and intermolecular attractive force.

Solid	Liquid	Gas
• Intermolecular attractive force is very high.	•	•
•	•	•

Table 5.1

In whatever state a substance be, their molecules are always in a state of motion. Hence they possess kinetic energy.

Let's try an experiment to understand the changes that take place in the speed of molecular motion on heating.

Wrap some potassium permanganate and a small stone using plastic coated paper. Make one more such packet. Put small holes in the packets using a needle. Take some hot water in one beaker and cold water in another. Put the prepared packets into the beakers at the same time. Write down your observations in the science diary.

See "States of Matter Basic" in PhET in IT @ School Edubuntu

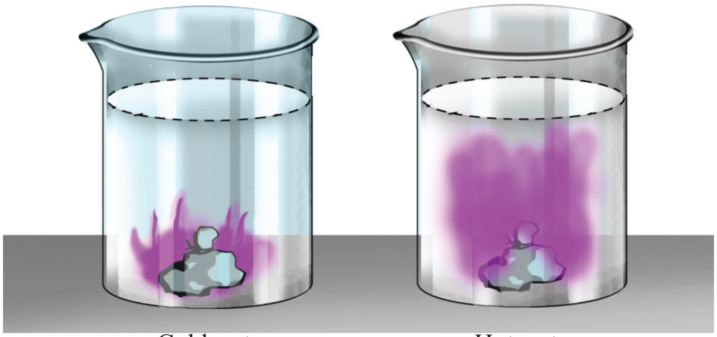


Fig. 5.1

- In which beaker does the colour spread faster?
- What is your inference from this?

The speed of the motion of molecules in hot water will be greater since they possess greater kinetic energy. Won't the speed of motion of potassium permanganate molecules dissolved in water also be high?

From this we can understand that the spreading of colour was faster in the case of hot water, due to the greater speed of molecules in it.

When any substance is heated, the speed of molecules in it increases.

Heat and temperature

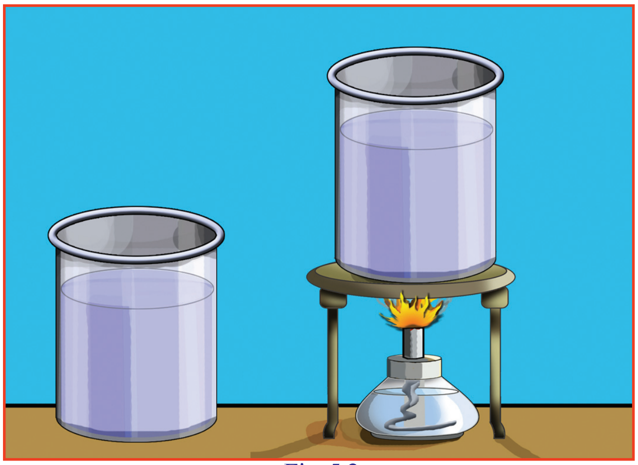


Fig. 5.2

Take equal amount of water in two beakers. Heat one of them for some time.

Now touch the water in both the beakers. What difference do you feel?

- Water in which beaker will be at a higher temperature?

  -

- Which is the form of energy absorbed by water to get heated?

  -

- What change happens to the kinetic energy of the molecules when the heat energy increases?

  -

- In which beaker the water molecules will have greater kinetic energy?

  -

The number of molecules of water in both beakers is the same since both of them contain the same amount of water. In which beaker will the average kinetic energy of molecules be greater?

- -

When the water is hot we say that its temperature has increased. Temperature is a term indicating how hot or cold a body is.

Temperature of a body is a physical quantity proportional to the average kinetic energy of molecules in it.

Heat of a substance is the total kinetic energy of the molecules in it. Temperature of a substance is a measure proportional to the average kinetic energy of the molecules in it. It is due to the difference in temperature that the heat flows from one point to another.

We cannot measure the exact temperature of a body by touching it.

You know that thermometers are used for measuring temperature. Usually mercury thermometers are used for this purpose.

The SI unit of temperature is kelvin (K).

Normally temperature is measured in degree celsius (^{o}C).

The unit of heat is joule (J).

The unit calorie is also used.

1 calorie = 4.2 joule (approximately).

Some statements related to heat and temperature are given. Tabulate them properly in Table 5.2.

- The SI unit is joule.
- Depends on the average kinetic energy of molecules in the body.
- Measure of the total kinetic energy of the molecules
- Unit is kelvin
- Decides from which body to which heat should flow, when two bodies of different temperatures are in contact.

Heat	Temperature
• SI unit is joule	• SI unit is kelvin.

Table 5.2

Fig. 5.3

Normally celsius thermometer is used for measuring temperature. Take such a thermometer and observe the markings on it.

- What is the temperature at which ice melts under normal atmospheric pressure?
- What is the temperature at which water boils?
- Observe where these temperatures are marked in a thermometer.

The mercury level, when the bulb of the thermometer is placed in melting ice at normal pressure, is marked as 0 °C (the melting point of ice) and that when water boils at normal pressure is marked as 100 °C (the boiling point of water). 1°C is the one part derived when the range from 0 °C to 100 °C is divided into 100 equal parts.

1 °C is $\frac{1}{100}$ of the measurement of the portion from melting point of ice to the boiling point of water.

Usually a clinical thermometer is used to measure the temperature of human body.

Compare a Celsius thermometer with a clinical thermometer and write down the differences in your science diary.

Clinical thermometer

In clinical thermometers Fahrenheit scale is used. According to this the melting point of ice is 32 °F and the boiling point of water is 212 °F. The range from 32 °F to 212 °F is divided into 180 equal parts. One such part is 1°F.

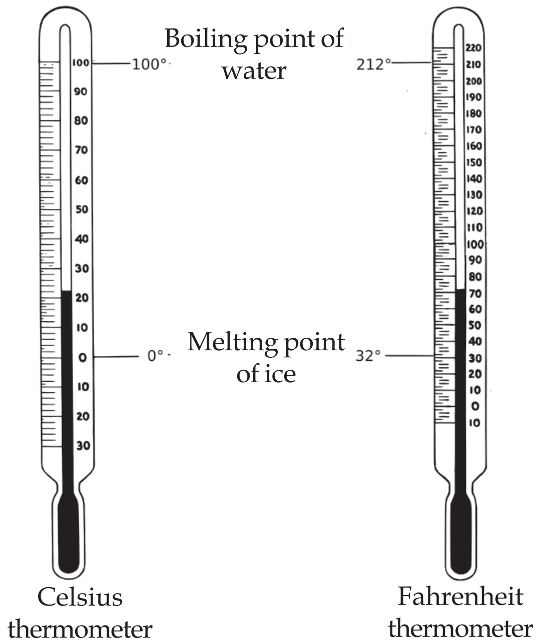


Fig. 5.4

The following formula can be used for understanding the relationship between the Celsius scale and Fahrenheit scale.

$$\frac{C}{100} = \frac{F-32}{180}$$

That is $\frac{C}{5} = \frac{F-32}{9}$

$$C = \frac{5}{9}[F-32]$$

That is $F = \frac{9}{5}C + 32$

- The normal human body temperature is 98.6 °F. How much is this in the Celsius scale?
- If the average temperature of a day is 30 °C, how much will it be in the Fahrenheit scale?

Infrared thermometer

All substances will release heat radiations (infrared radiations) proportional to their temperatures. Infrared thermometer is a device to measure the temperature of a substance by receiving these radiations using sensors. The main advantage of this device is that we can measure the temperature of a substance from a distance without touching it.

The infrared radiations coming through a lens is directed to a detector. These radiations are changed into electric signals and the proportionate temperature appears on a display.

This thermometer is made use of in clinics to measure body temperature. Besides, this device is used to measure the temperature of certain parts of mechanical and electrical devices, as well as to calibrate heating devices.

Using a graph we can easily find out Fahrenheit temperature (°F) and the equivalent Celsius scale (°C) temperature.

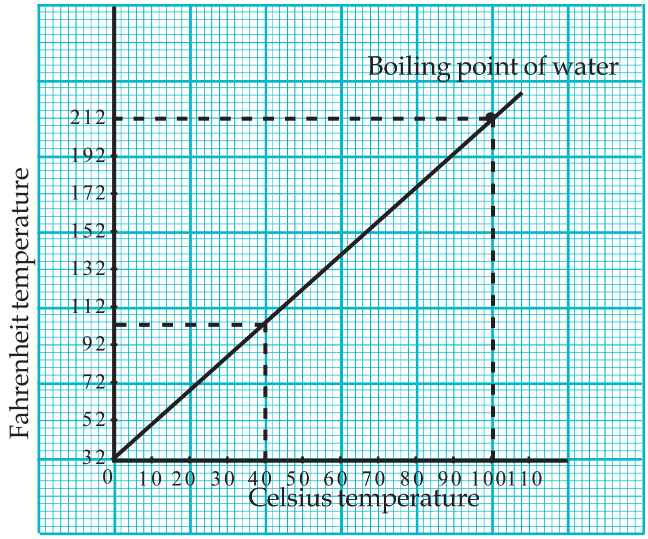


Fig. 5.5

The temperature of the human body is 37 °C. Find out the equivalent temperature in °F from the graph and write it down in the science diary.

We use another scale also to measure the temperature.

Kelvin Scale

Based on thermal expansion of gases, Kelvin scale is designed for measuring temperature. The kinetic energy of molecules becomes zero at -273 °C (-273.15 °C to be exact) and this temperature is taken as 0 K. This temperature is the absolute zero. The name absolute zero is derived on the basis that this is the lowest possible temperature. In this scale, the melting point of ice is 273 K.

°C = 273 K

0 K = - 273 °C (approximately)

The relationship between Celsius scale and Kelvin scale can be understood from this.

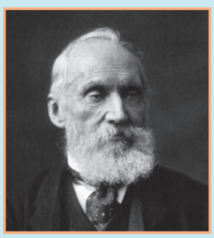
$$T = t + 273$$

T = temperature in Kelvin scale

t = temperature in Celsius scale

Unit difference in temperature is the same in both Celsius scale and Kelvin scale.

Lord Kelvin



Lord Kelvin was a British scientist who designed the Kelvin scale. Born at Belfast in Ireland in 1824, his full name was William Thomson Baron Kelvin. He invented the Joule Thomson effect. It was he who calculated that the absolute zero is - 273.15 °C and its Fahrenheit value is - 459.67 °F. He passed away at the age of 83 on 17 December 1907 in Scotland.

Using a graph we can easily find out Fahrenheit temperature (^{o}F) and the equivalent Celsius scale (^{o}C) temperature.

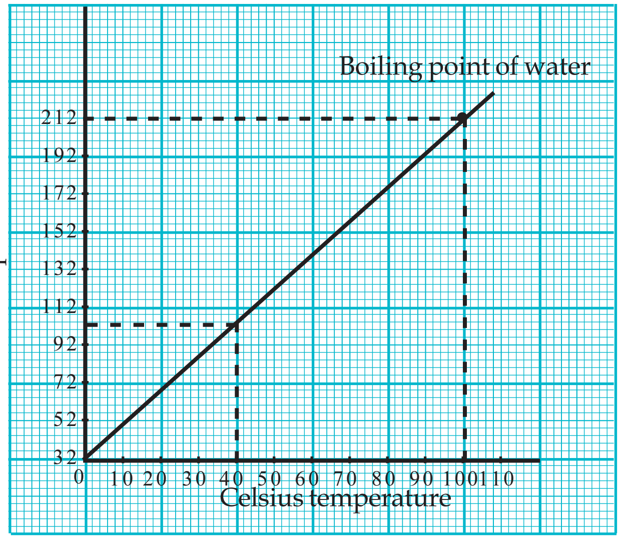


Fig. 5.5

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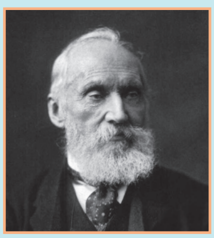

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Cryogenics

Cryogenics is the branch of science that deals with the study of extremely low temperatures and the methods of producing them. There are many uses in daily life for liquid nitrogen, oxygen, and hydrogen produced with the help of cryogenic technology. James Dewar is the scientist who first liquefied hydrogen.

Liquid hydrogen is used as a fuel in rockets. Such engines are referred to as cryogenic engines. Cryogenic engines are used in the last stage (*third stage*) of Indian space launching vehicle GSLV.

Cryogenics is made use of in the industrial production of LNG (*Liquefied Natural Gas*) and its distribution.

Cryogenics is also used in preserving sperms and ovum for artificial insemination.

Liquid nitrogen is used in clinics to produce temperatures from -25 °C to -50 °C. When liquid nitrogen is applied in required quantity on a part of the body that part can be brought down to this temperature in 30 s.

On the basis of the data from the table it can be seen that 420000 J of heat is required to raise the temperature of 10 kg of coconut oil by 20 K. If so the heat required to raise the temperature of 10 kg of coconut oil by 1 K = $\frac{420000}{20}$ = 21000 J.

The heat energy required to raise the temperature of a substance by 1 K is the heat capacity of that substance.

Its unit is J/K.

It can be understood from the table 5.4 that the heat energy required to raise the temperature of two different substances of the same mass by the same measure is different.

We have seen that the heat energy required to raise the temperature of 10 kg of coconut oil by 1 K is 21000 J. If so how much is the heat energy required to raise the temperature of 1 kg of coconut oil by 1 K?

The heat energy required to raise the temperature of 1 kg of coconut oil by 1 K = $\frac{21000\ \text{J/K}}{10\ \text{kg}}$ = 2100 J/kg K.

This is the specific heat capacity of coconut oil.

The heat energy required to raise the temperature of a substance of mass 1 kg by 1 K is the specific heat capacity of that substance.

Specific heat capacity =

$$\frac{\text{The amount of heat energy given}}{\text{Mass} \times \text{increase in temperature}}$$

Unit of specific heat capacity =

$$\frac{\text{Unit of heat}}{\text{unit of mass} \times \text{unit of temperature}}$$

$$= \frac{\text{joule}}{\text{kilogram} \times \text{kelvin}} = \text{J kg}^{-1}\,\text{K}^{-1}$$

The specific heat capacity of some substances are given in table 5.5.

- In the table which substance has the highest specific heat capacity?

Explain the following life situations based on the high specific heat capacity of water.

- The variations in atmospheric temperature do not affect our body instantly.
- Water is used as a coolant in the radiator of engines.

Substance	specific heat capacity $J\ kg^{-1}\ K^{-1}$
Water	4186
Ice	2130
Steam	460
Sea water	3900
Glass	500
Iron	460
Copper	385
Silver	234
Lead	120

The specific heat capacity of water is 4186 $J\ kg^{-1}\ K^{-1}$. It is assumed as 4200 $J\ kg^{-1}\ K^{-1}$ for ease in numerical problem solving

Table 5.5

Find out more situations in daily life where the high specific heat capacity of water is used and note them down in your science diary.

- The specific heat capacity of sand is only $\frac{1}{5}$ times that of water. Hence the heating and cooling of land is five times faster than that of water. You have already learnt about the formation of land breeze and sea breeze. Based on the specific heat capacity, prepare notes on how land breeze occurs in the day time and sea breeze in the night time, and write them down in the science diary.

The quantity of heat

You know that the heat energy required to raise the temperature of a substance of mass 1 kg by 1 K is the specific heat capacity(c) of that substance.

Won't the heat required to raise the temperature of a substance of mass m kg by 1 K be m × c? If so how much will be the heat required to raise the temperature of a substance of mass m kg by θ K?

If the mass of a substance is m and its specific heat capacity is c then the quantity of heat required to raise the temperature of the substance by θ K is $Q = mc\theta$.

Complete the table.

Substance	Mass (m) kg	specific heat capacity (c) J kg^{-1} K^{-1}	Increase in temperature (θ) K	Heat received by the substance (Q = mcθ) J
Copper	1	385	10	3850
Iron	1	460	20	-
Water	2	4200	-	42000
Lead	1	-	10	1200

Table 5.6

- Calculate the quantity of heat required to raise the temperature of 5 kg iron from 303 K to 343 K (specific heat capacity of iron is 460 J/kg K).
- The temperature of 0.5 kg of water is 303 K. It is cooled to 278 K by keeping it in a refrigerator. What is the time taken by the water to reach 278 K if 87.5 J of heat is given out in each second? (the specific heat capacity of water is 4200 J/kg K)

Principle of method of mixtures

Take 0.2 kg of cold water in a glass beaker and the same amount of hot water in another. Measure the temperature of both using a thermometer and record them in the table. Pour cold water into the hot water and stir. Find out the resultant temperature and record it in the table

Water	Initial temperature θ_1	Resultant temperature of mixture θ_2	Difference in temperature	Heat gained/ heat lost
Cold				
Hot				

Table 5.7

- Based on the table, calculate the quantity of heat gained by the cold water,
- How much heat is lost by the hot water?

Analyse the table and examine the relationship between the heat lost by the hot water and the heat gained by the cold water. What can be inferred from this?

Heat lost = Heat gained

When a hot body is in contact with a cold body, heat flows from the hot body to the cold body, till both the bodies attain the same temperature. The heat lost by the hot body = heat gained by the cold body. This is the principle of method of mixtures.

- 4 kg of hot water at 343 K is added to 6 kg of water at 293 K. The resultant temperature is 313 K. Calculate the heat lost by the hot water and heat gained by the cold water assuming that there is no heat loss to the surroundings.

Cold water

Mass (m)	=	6 kg
Initial temperature (θ_1)	=	293 K
Final temperature (θ_2)	=	313 K
Difference in temperature ($\theta_2 - \theta_1$)	=	313 - 293 = 20 K
The specific heat capacity of water (c)	=	4200 J/kgK
Heat gained	=	mc ($\theta_2 - \theta_1$)
	=	$6 \times 4200 \times 20$
	=	504000 J

Hot water

Mass (m)	=	4 kg
Initial temperature (θ_1)	=	343 K
Final temperature (θ_2)	=	313 K
Difference in temperature ($\theta_1 - \theta_2$)	=	343 - 313 = 30 K
Heat lost by the hot water	=	mc ($\theta_1 - \theta_2$)
	=	$4 \times 4200 \times 30$
	=	504000 J

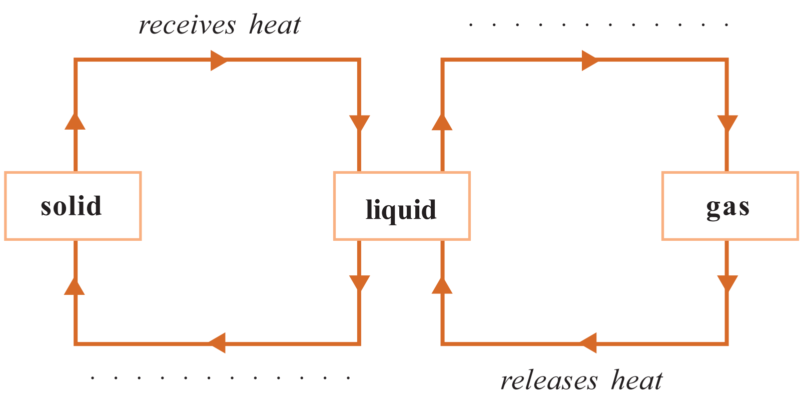
Haven't you understood that the heat lost by the hot water = heat gained by the cold water.

- In a bucket there is 8 kg of water at 298 K. To this 2 kg of water at 353 K is added. Calculate the resultant temperature assuming that the bucket and the surroundings do not receive any heat.

If we go on heating water in a vessel, the quantity of water in it goes on decreasing. What is the reason? Let's see.

Change of state

You know that a body undergoes a change in its physical state by receiving or losing heat. Complete the flow chart given below.



Why do substances release or absorb heat on undergoing a change of state? Let's try an activity.

Fill half a beaker with ice pieces. Insert a thermometer into it. Fix the thermometer in a stand in such a way that the thermometer does not touch the walls of the beaker. Record the temperature shown by the thermometer in table 5.8.

Slowly heat the beaker in a water bath. Record in every 30 second the temperature shown by the thermometer. At the same intervals of time, record the changes that happen in the ice pieces as well.

	Time (s)									
	30	60	90	120	150	180	210	240	270	300
Temperature										
Changes in the ice pieces										

Table 5.8

Using the temperatures obtained draw a time – temperature graph. The graph should be drawn with time in the X - axis and temperature in theY - axis.

Compare the graph obtained with that given in Fig. 5.6. Answer the following questions, based on the graph.

- What is the temperature of the ice after 60 s?
- Is the ice melting at this time?
- Are there ice pieces left in the beaker when the temperature starts to rise?
- Is the ice undergoing any change in the time from 0 to A in the graph?
- Is there any change in the temperature from 0 to A? What may be the reason? Discuss.

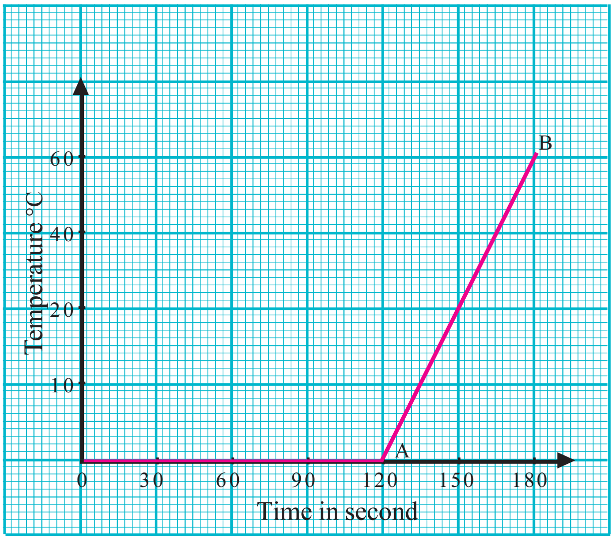


Fig 5.6

The heat received during the change of state is used for increasing the potential energy of molecules in the substance. Hence the temperature does not change.

The entire heat energy we supply during the change of state is absorbed by the molecules and solely used up to overcome the intermolecular attractive force. Hence the temperature does not change though heat is being absorbed. The heat absorbed is used up completely to separate the molecules.

When a solid is changing into a liquid or liquid is changing into gas, the entire heat energy absorbed is spent to separate the molecules. A change of state occurs because the molecules are moving apart. In otherwords there is an increase in the potential energy of the molecules

- What happens to the potential energy of molecules when a substance changes from gaseous state to liquid state or liquid state to solid state? Write it down.

Is there a change in temperature when solid changes into liquid or liquid changes into gas? What are these fixed temperatures known as?

The fixed temperature at which a solid changes into its liquid state under normal atmospheric pressure is the melting point. A liquid changes into its solid form at the same temperature. This temperature is its freezing point. Both these are equal.

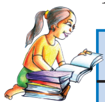
A substance receives 500 J of heat on changing from solid state to liquid state without change in temperature. How much heat will it release when it changes from liquid state to solid state?

Latent heat of fusion

Latent heat of fusion (L_f) of a solid is the quantity of heat absorbed by 1 kg of the solid to change into its liquid state at its melting point without change in temperature.

How much heat is required to convert a substance of mass m kg completely into its liquid form at its melting point?

The latent heat of fusion of some substances is tabulated:



Substance	Melting point (°C)	Latent heat of fusion J/kg
Ice	0	335×10^3
Silver	962	88×10^3
Copper	1083	180×10^3

Table 5.9

Explain the following based on the high latent heat of fusion of ice.

- Glaciers do not melt as a whole at the same time.
- Ice cream does not melt fast.
- It feels much colder when an ice piece at 0 °C is placed in the mouth than when drinking water that is at 0 °C.
- 1.5 kg of copper at 1083 °C and 1 kg of ice at 0 °C are melting and changing into their liquid state at their respective temperatures. Which of them needs more heat?

  (L_f of ice = 335×10^3 J/kg, L_f of copper = 180×10^3 J/kg)
- Calculate the quantity of heat required to convert 5 kg of ice at 0 °C into water at the same temperature.

  (Latent heat of fusion of ice = 335×10^3 J/kg)

Vaporisation

You have learnt that a matter in solid state can be changed into its liquid state or from its liquid state into its gaseous state on heating.

The boiling point of a substance is the fixed temperature at which a liquid boils and changes into its gaseous state at normal atmospheric pressure. Vaporisation is the process by which a liquid changes into its gaseous state at its boiling point.

A graph drawn using the temperature at different intervals while converting water into steam is given in Fig. 5.7. Analyse the time – temperature graph and answer the following.

- In which state of matter is water from A to B in the graph?
- What can you understand about the state of water from B to C in the graph?

We can see that there is a change of state from B to C. On observing the graph we can realise that the temperature does not rise though heat is being absorbed.

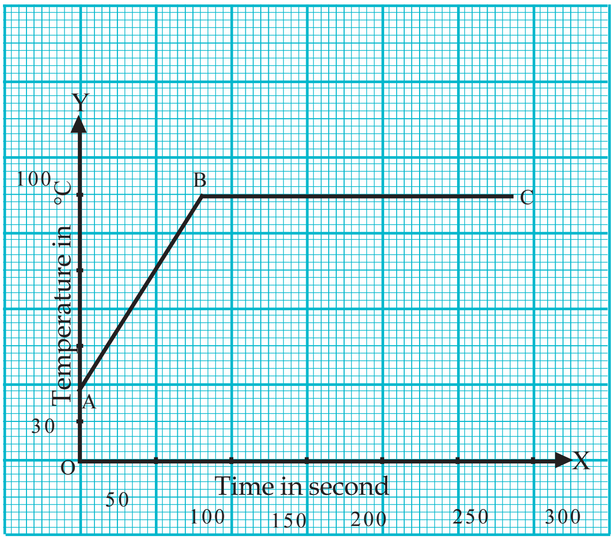


Fig 5.7

Latent heat of vaporisation (Lv) of a substance is the quantity of heat absorbed by 1 kg of the liquid to change into its gaseous state at its boiling point without change in temperature.

The quantity of heat required for converting a liquid of mass m kg and latent heat of vaporisation L_v into its gaseous form is mL_v.

The latent heat of vaporisation of some substances is given.

Substance	Boiling point	Latent heat of vaporisation (J/kg)
Methanol	64 °C	112×10^4
Ethanol	79 °C	85×10^4
Mercury	357 °C	27×10^4
Water	100 °C	226×10^4

Table 5.10

- In the above table, which substance has the highest latent heat of vaporisation?

The high latent heat of vaporisation prevents the loss of water on the earth.

Write down the situations from daily life in which we make use of the high latent heat of vaporisation.

- Cooking of food is faster when it is done in steam.

Water and boiling point

The boiling point rises with increase in pressure. When the boiling point of water increases, it can contain more heat. The pressure cooker works on this principle.

Substances dissolved in water will increase its boiling point. When propylene glycol is added to water the boiling point increases to 129 °C. This property is made use of in using coolants.

- Steam is used for the working of a thermal power station.
-

"The blister caused by steam is said to be more severe than that caused by boiling water at the same temperature". Explain.

- What are the methods to increase the boiling point of a liquid?
- How is it possible to cool down engines by using coolants?
- 1 kg steam at 100 °C is condensed at the same temperature and then allowed to cool to 30 °C. Calculate the heat given out during this process.

  ($L_v = 226 \times 10^4$ J kg^{-1}, c = 4200 J kg^{-1} K^{-1})

Evaporation

Take two watch glasses with spirit in one of them and vinegar in the other. Place them at the farther ends of a table. The presence of both can be detected by their smell.

- Is there a change of state for spirit? What about vinegar?
- Did we heat them for evaporation?
- How did they evaporate?

Evaporation is the process by which a liquid changes into its vapour form by absorbing heat from the surroundings. This is a normal process that takes place on the surface of the liquid at all temperatures.

Keep in your hand a piece of cotton dipped in spirit. What do you feel? Why?

Isn't this due to absorption of heat by spirit from your hand? Wrap the bulb of a thermometer with a little cotton.

Record the temperature shown by the thermometer. Wet the cotton using spirit. Observe and record the changes in temperature.

- What happened to the temperature in the thermometer?
- What is your inference based on the changes in temperature?

In the above activities liquid molecules on the surface are freed and changed into vapour form. This is a slow process that happens at all temperatures. During evaporation the substance which supplies heat gets cooled.

Some situations from our day to day life in which evaporation is made use of are given below. Expand the list.

- Water kept in an earthern pot cools well.
- A sweating person feels more cold if he is sitting under a fan.
- A wet hand feels cold when it is waved.
-

What happens to the rate of evaporation when a wet cloth is kept crumbled and when it is kept stretched? The rate of evaporation increases with increase in the surface area. Write down other factors that influence the rate of evaporation.

- Nature of substances
- Atmospheric temperature
- Wind
-

You might have conducted experiments related to heat, evaporation, change of state, etc. Won't the heat liberated in each situation cause a change in the atmospheric temperature?

Global warming

Global warming is an issue discussed worldwide in connection with environment protection. Global warming is the phenomenon by which the temperature of the earth's surface and the atmosphere increases due to excess of green house gases.

- Which are the green house gases?
- What are the circumstances that have led to the increase in green house gases?
- Which is the radiation that causes global warming?
- Which are the environmental problems that arise due to global warming?

Global warming

Carbon dioxide, water vapour, methane, chloro fluoro carbon (CFC) etc., are known as green house gases. The earth absorbs the infrared radiations of lower wavelengths emitted by the sun and releases them as infrared radiations of higher wavelengths. Every year the temperature of the earth's atmosphere increases slightly since these infrared radiations are absorbed by the above gases.

The amount of CO_2 in the atmosphere increases beyond limits due to industrialisation, excessive use of fuels, deforestation, etc. The amount of methane in the atmosphere increases due to natural gas exploration, decay of biomass and leak in the gas pipe lines. The concentration of CFC released into the atmosphere increases by 5 % every year.

Global warming causes the ice in the polar regions to melt. The sea water level rises up causing some coastal areas to submerge and some islands to vanish. The ecosystems of both land and sea may get annihilated. Coral reefs as well as coral islands may get destroyed. This may cause flood, hot and dry winds and cyclones.

If we do not prevent global warming, which is a threat to the very existence of life on earth, it will be a great injustice we do to future generations. Give suggestions to prevent global warming.

- Avoid the excessive use of fossil fuels.
- Reduce the use of CFC (Chloro fluoro carbon).
- Reduce the further production of green house gases.
- Find out an effective method to use hydrogen as a fuel.
- Use non conventional sources of energy to the maximum for our energy needs.
-

Collect more details and figures connected with global warming and exhibit on the school bulletin board.

Significant Learning Outcomes

The learner can

- describe that molecules of a substance are in motion and hence they possess kinetic energy.
- find out that heat and temperature are different and are related to the kinetic energy of the molecules, identify and present their units.
- prove practically that matter can be changed from one state to another.
- measure the temperature using thermometer, convert it from one scale to another and compare the units.
- distinguish between specific heat capacity and latent heat, and describe them
- apply the concept that evaporation produces cooling and find out its influence in daily life.
- explain global warming, the reasons for it, suggest remedies and apply them in daily life situations.

Let us assess

1. What are the following temperatures in the celsius scale?

   (a) $491.67\ ^{o}F$ (b) $673\ K$

2. Water containing propylene glycol is used as coolant in engines.

   a) Which property of water makes it a coolant?

   b) What is the advantage of adding propylene glycol to the water used as coolant?

3. A wet cloth is placed on the forehead of a person having fever. What is the scientific reason behind it?

4. "The high specific heat capacity of water causes land breeze and sea breeze". Write down your comments about this statement.

5. Write down an example to know how the following factors influence the rate of evaporation.

   a) Surface area   b) Wind

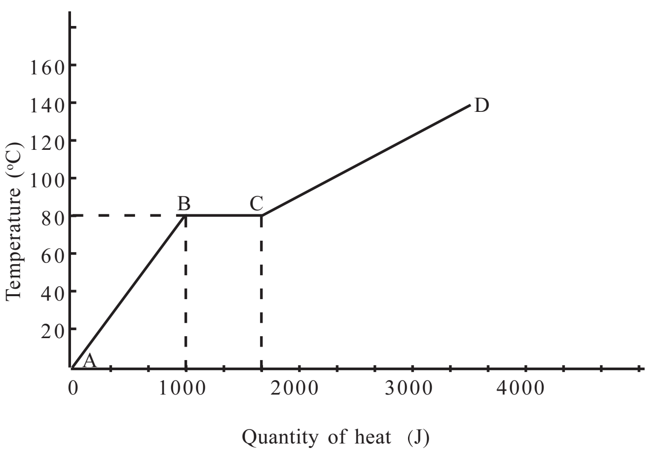
6. When will cool drinks get cooled faster - on placing ice cubes at 0 ^oC or on adding water at 0 ^oC? Justify your answer.

7. 2 kg of water at 293 K is converted completely into ice at 273 K. Calculate the heat liberated.

Extended activities

1. 2 kg of ice at -10 ^oC is continuously heated to melt it completely. Calculate the quantity of heat required. (The latent heat of fusion of ice: 336×10^3 J/kg. The latent heat of vaporisation of water: 226×10^4 J/kg. Specific heat capacity if ice: 2.1×10^3 J/kg K. Specific heat capacity of water: 4.2×10^3 J/kg K.)

2. A solid of initial temperature 0 ^oC is heated. A graph showing changes in the temperature according to the heat supplied is given below.



Based on the graph calculate the following. (Specific heat capacity of the substance : 500 J kg^{-1} K^{-1})

a) the mass of solid substance

b) the latent heat of fusion of the substance

3. A hole was drilled in an ice block at 273 K. When the hole was filled with water at 373 K, 2 kg of ice melted and changed into water at 273 K. If so, what is the mass of water at 373 K that was used? (Specific heat capacity of water 4200 J kg^{-1} K^{-1}, latent heat of fusion of ice : 336×10^{3} J/kg)

4. Collect information regarding different kinds of thermometers and record the situations in which they are used. (hint: maximum – minimum thermometer).

Notes

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