PHYSICS

Standard X

Part 1

Government of Kerala
Department of General Education

Prepared by

State Council of Educational Research and Training (SCERT), Kerala
2025

THE NATIONAL ANTHEM

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

PLEDGE

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

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

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

State Council of Educational Research and Training (SCERT)
Poojappura, Thiruvananthapuram 695012, Kerala
Website : www.scertkerala.gov.in
e-mail : scertkerala@gmail.com, Phone : 0471 - 2341883,
Typesetting and Layout : SCERT
First Edition : 2025
Printed at : KBPS, Kakkanad, Kochi-30

PREFACE

Dear learners,

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

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

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

Dr.Jayaprakash R K
Director
SCERT, Kerala

TEXTBOOK DEVELOPMENT COMMITTEE

Advisor

Dr. Salahuddin Kunju A
Principal (Rtd.)
University College, Thiruvananthapuram

Chairperson

Prof. P S Sobhen
Head (Rtd.), Department of Physics
Maharaja's College, Ernakulam

Experts

Dr. N Shaji
Adjunct Faculty
Department of Physics
CUSAT, Kochi

Dr. P Sethu Madhavan
Prof. (Rtd.)
SNG College,
Kozhikode

Dr. B Premlet
Prof. (Rtd.)
TKM College of Engineering,
Kollam

Writers

Sunilkumar M
BPC, BRC Cheruvathur,
Kasaragod

Bhavana R
HST (Physical Science)
TEMVHSS, Mylode,
Kollam

Pradeepkumar K V
HST (Rtd.) (Physical
Science)
Muthedath HSS,
Thalipparambu, Kannur

Unnikrishnan T I
Headmaster (Rtd.)
AKKRHS for Boys,
Kozhikode

Unnikrishnan M
HST (Physical Science)
Brothers HSS,
Mavandiyur, Malappuram

Kanchana R
HST (Physical Science)
GHSS Thottakkonam,
Pathanamthitta

Shaji K V
HST (Physical Science)
GHS, Vazhamuttom
Pachalloor,
Thiruvananthapuram

Sureshkumar K
HST (Rtd.), (Physical Science)
AMHSS, Thirumala,
Thiruvananthapuram

English Version

Dr. Manoj Kumar N
Asst. Professor,
Dept. of Physics,
Payyanur College, Kannur

Pradeep K
HST Physical Science (Rtd.)
GVHSS Koyilandy

Anjali C K
Asst. Professor (Former)
Dept. of Language & Literature
St.Joseph's College, Devagiri,
Kozhikode

Annie Joseph
HSST English (Rtd.)
St.Joseph's AIGHSS
Kozhikode.

Baby John Thottam
HST Physical Science
St. Joseph's Anglo-Indian
Girls' HSS, Kozhikode.

Artists

Mustajib E C
MMETHSS Melmuri,
Malappuram

Lohithakshan K
Assisi HSS for Deaf
Malapparambu, Malappuram

Academic Co ordinator

Dr. Ancey Varughese
Asst. Professor, SCERT

State Council of Educational Research and Training (SCERT)
Poojappura, Thiruvananthapuram 695012, Kerala

Contents

Certain icons are used in this textbook for convenience

- For further reading (Evaluation not required)
- Questions that may be raised by students
- Continuous assessment questions
- ICT Possibilities
- Let's Assess
- Extended Activities

THE CONSTITUTION OF INDIA

PREAMBLE

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

JUSTICE, social, economic and political;

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

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

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

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

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

1 Sound Waves

Why did the teacher agree with the child on the swing?

How should the swings be counted?

- What type of motion does the swing have? (circular / oscillatory)

Observe the diagram showing the motion of the swing.

Fig. 1.1 (a)

- What is the initial position of the swing when it starts oscillating from its free state (equilibrium position)?

  (A / O / B)

Oscillation is a periodic motion in which an object moves to and fro at regular intervals of time about its equilibrium position.

- In the figure, what is the maximum displacement to one side from the equilibrium position?

  $(2a, \frac{a}{2}, a)$

The magnitude of maximum displacement to one side from its equilibrium position is amplitude. The symbol of amplitude is a. The SI unit of amplitude is metre (m).

- When does the swing complete one oscillation?

(when the pendulum starts from O, reaches A and returns to O / when the pendulum starts from O, reaches A, then to B and back to O)

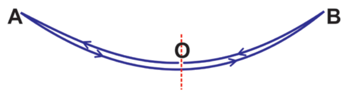


Fig. 1.1(b)

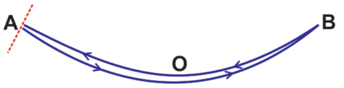


Fig. 1.1(c)

A swing completes one oscillation when the pendulum starts from O, goes to both sides and then returns to O [Fig 1.1(b)].

An oscillation is completed when the body returns to its initial position in the same direction from where it started.

What if counting starts from A? A swing completes one oscillation when it starts from A, reaches B and returns to A [Fig 1.1 (c)].

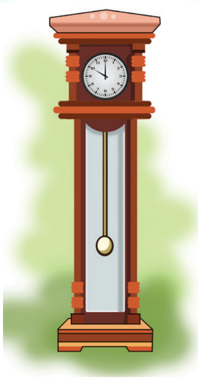


Fig. 1.2

In early pendulum clocks (Grandfather's clock), pendulum (seconds pendulum) of length 99.35 cm (about 1 m) was used. It was made of an alloy called invar (invar-invariable).

What could be the reason that the number of oscillations counted by the child waiting for his turn to swing and the child on the swing were different? Discuss and find out. Now you have understood how to count oscillations accurately.

Give more examples of oscillatory motion.

- Motion of the pendulum of a clock
-

Have you ever noticed how many oscillations the pendulum in a clock completes for a time change of one minute?

- If a pendulum takes 1 minute to complete 30 oscillations, how long does it take to complete one oscillation?

Time for 30 oscillations = 1 minute = 60 s

Time for 1 oscillation $= \frac{60\text{ s}}{30} = 2\text{ s}$

The time taken for one oscillation is called period. Its symbol is T. SI unit of period is second (s).

- Find the number of oscillations the same pendulum completes in one second.

Number of oscillations in 1 minute (60 s) = 30

$\therefore$ Number of oscillations in 1 second $= \frac{30}{60}$

$= \frac{1}{2} = 0.5$

The number of oscillations in one second is called frequency. The SI unit of frequency is hertz (Hz). Frequency is denoted by the letter f.

Heinrich Rudolf Hertz

Lifetime : 1857 - 1894

Place of birth : Hamburg, Germany

Major contributions : Experimentally proved the presence of electromagnetic waves. Laid the foundation for the future advancements of the radio, telephone, telegraph and television. Discovered photoelectric effect. The unit of frequency was named hertz, to honour him.

Let's find the period and frequency of a pendulum by swinging it at low amplitude. Tie a bob to a string and hang it on a stand. This system is called a simple pendulum. Complete table 1.1 by doing an experiment using a simple pendulum, meter scale, and a stopwatch.

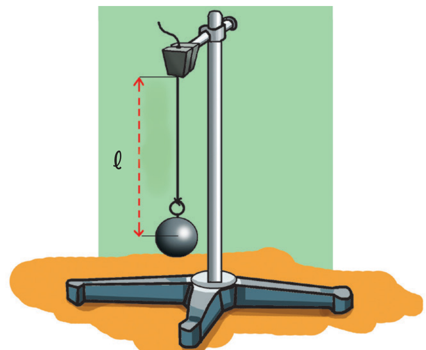


Fig. 1.3

Length of the pendulum (ℓ) cm	Time taken for 10 oscillations s	Period (T) $= \frac{\text{Total time}}{\text{Number of oscillations}}$ s	Frequency (f) $= \frac{\text{Number of oscillations}}{\text{Time}}$ Hz
25			
60			
100			

Table 1.1

- What is the change in frequency when the length of the pendulum increases? (increases / decreases)

When the length of the pendulum increases, frequency decreases.

PhET⟶ Pendulum bob

- What is the relation between period and frequency?

The time required for one oscillation = T

Number of oscillations per second = f

In radio and television transmission you may have heard the units kilohertz and megahertz. These are also practical units of frequency.

1 kHz = 1000 Hz = 10^3 Hz

1 MHz = 1000000 Hz = 10^6 Hz

$$\text{Frequency (f)} = \frac{1}{\text{period (T)}}$$

As the period increases, frequency decreases.

Aren't tuning forks used for experiments connected with sound? Have you noticed the marking on them? Observe various tuning forks and note down the markings on each of them with their units.

- 256 Hz
-

Is there any relation between the marking on the tuning fork and its number of vibrations?

The marking on a tuning fork indicates the frequency of the tuning fork. Excite tuning forks of different frequencies in a similar manner and listen to the sound.

- Do you feel any difference?

Note the frequency marked on each of them.

- Isn't the difference in frequency the reason for the difference in sound here?

Find the number of times each tuning fork vibrates independently in one second using the ICT facility (Audio Frequency Counter).

When an object vibrates freely, it vibrates in its innate frequency. This is the natural frequency of that object.

Factors that influence the natural frequency of an object :

- Length of the object
- Size of the object
- Elasticity
- Nature of the material etc.

Change in any one of these factors will affect the natural frequency of an object.

Do all objects vibrate only in their natural frequency?

Forced Vibration & Resonance

Have you ever felt the vibration of the table when a mixie kept on the table works?

Excite a tuning fork and listen to it. What is the change in the sound heard when the stem of the excited tuning fork is pressed on the table? What could be the reason for the sound being louder?

In this case, the sound became louder because the table also vibrated along with the tuning fork.

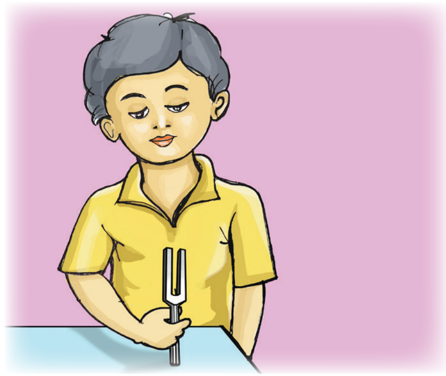


Fig. 1.4

Forced vibration is the vibration of an object induced by an external vibrating object.

Observe figure 1.5 (a).

Try the activities given below using the device in which two sets of three identical hacksaw blades each of length about 13 cm and 17 cm are fixed between two wooden blocks.

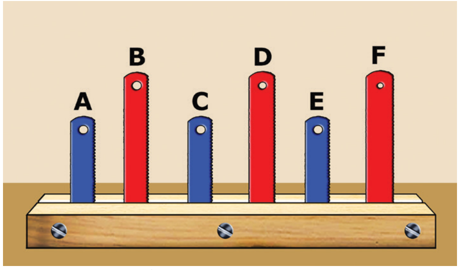


Fig. 1.5 (a)

- Excite the hacksaw blade A by tapping with your finger. What do you observe?
  (all blades vibrate / only A vibrates)
- Are all the blades vibrating with the same amplitude?
- Which of them vibrates with maximum amplitude?
- After all the blades have stopped vibrating, excite B and record the observation in the science diary.
- When blade A vibrates why would the hacksaw blades C and E vibrate with maximum amplitude?

Since the natural frequency of C and E are equal to the natural frequency of A, they vibrate with maximum amplitude.

If the natural frequency of the forcing object and that of the forced object are equal, the objects are said to be in resonance. The objects undergoing resonance will vibrate with maximum amplitude.

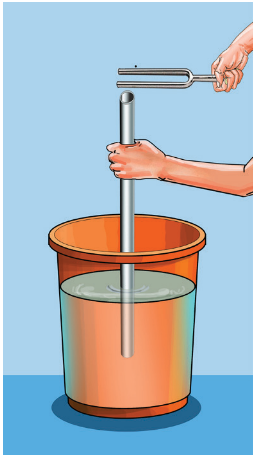


Fig. 1.5 (b)

- Immerse in water a PVC pipe of about 50 cm length and 4 cm (1½ inch) diameter. Excite a tuning fork of frequency 512 Hz and hold it close to the mouth of the pipe. Vary the length of the air column inside the pipe by gradually raising both the tuning fork and the pipe. Don't you hear a louder sound at a particular stage? What could be the reason for this? Record in your science diary.

Applications of forced vibration and resonance

- MRI scanning
- Radio tuning
- In musical instruments like guitar, violin, veena, harmonium, mridangam etc.
- Can't you hear even the faintest sound of the heartbeat when you listen to it using a stethoscope? A stethoscope used to listen to even a feeble sound in the body utilises forced vibration and resonance.
- In instruments like megaphones, horns and musical instruments such as trumpets and *nagaswaram*.

Fig. 1.6 (a)

Fig. 1.6 (b)

? **The frequency of a simple pendulum is 1 Hz. What is its period?**

? **If a pendulum takes 0.5 s to complete one oscillation, what is its frequency?**

? **A tuning fork of frequency 512 Hz is excited and its stem is pressed on a table. Does the table vibrate in this situation? What is this phenomenon known as?**

When a tuning fork of frequency 256 Hz vibrates, the air around it and the eardrum of the person hearing that sound vibrate 256 times per second.

How does the air near it vibrate when the tuning fork vibrates?

Wave Motion

A child conducted an experiment in connection with the transmission of sound in the school science club. A scene during the experiment is illustrated here.

Place light paper balls inside a long, transparent tube closed at one end. Pass a loud sound with uniform frequency through the free end of the tube. The paper balls are seen vibrating back and forth from their equilibrium position. Without moving the paper balls to the other end, they are found to be close in some regions and apart in some other regions alternately. How is it formed?

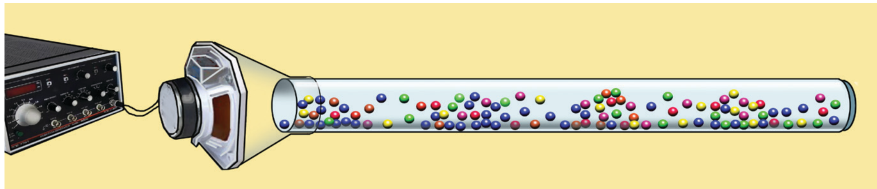
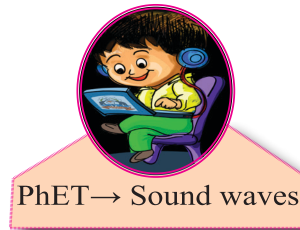


Fig. 1.7



Let's do an activity.

Stretch both ends of a slinky placed on a table as shown in figure 1.8 (a).

Compress and release a few coils at one end of the slinky. Notice the disturbance formed in the slinky.

Move one end of the slinky back and forth as shown in figure 1.8 (b). What do you observe?

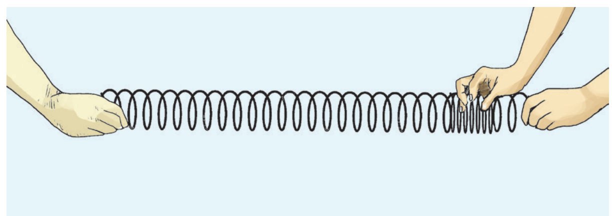


Fig. 1.8 (a)

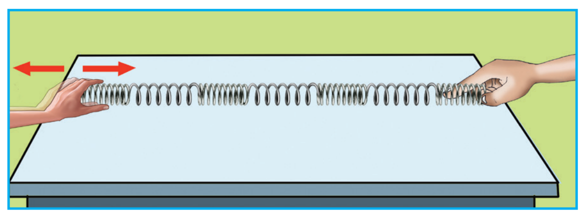


Fig. 1.8 (b)

Don’t you see the disturbances formed in the slinky moving from one end to the other?

- Are the coils in the slinky moving towards the other end along with the disturbances?

It is seen that the disturbance formed in one part of the slinky spreads to the other parts without any displacement of the coil.

Here the energy received in one part of the medium spreads to the other parts by transferring it to the adjacent part and so on.

Wave motion is one of the modes of transfer of energy from one part of the medium to other parts.

The continuous propagation of energy from one part to the other parts through oscillations is called wave motion.

Some examples of waves are given below :

- Radio waves
- Seismic waves
- Light waves
- Sound waves
- Ripples on the surface of water

- Do all these waves require a medium to travel? Complete table 1.2 appropriately.

Waves that require a medium for transmission	Waves that do not require a medium for transmission
• Seismic waves	• Radio waves
•	•

Table 1.2

Electromagnetic Waves

Radio waves, microwaves, infrared rays, visible light, ultraviolet rays, X-rays and gamma rays are electromagnetic waves. They do not require a medium for transmission.

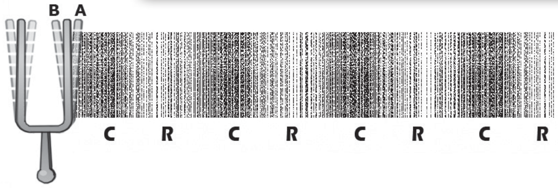
Mechanical Waves

Mechanical waves are those that require a medium for transmission. Mechanical waves are mainly of two types. They are longitudinal waves and transverse waves.

Longitudinal Waves

- In figure 1.8 (b), did the coils in the slinky move parallel or perpendicular to the direction of propagation of the wave?

Longitudinal waves are those in which the particles in the medium vibrate parallel to the direction of propagation of the wave.



Pressure variations occurring in air when the tuning fork vibrates

Fig 1.9

We have studied that sound requires a medium for transmission. Let's see how sound travels through air. Observe the picture.

- In figure 1.9, as the prong of the tuning fork moves from the equilibrium position to the side A, the air pressure on that side (increases / decreases).
- What about the air pressure on side A when the same prong moves to side B?
- When the prongs of the tuning fork vibrate continuously, aren't regions of high and low pressure formed intermittently in the air?
- Compare the wave produced in the slinky with the wave produced by the tuning fork in the air.

Sound from a source creates continuous and regular pressure variations in the air. A region of high pressure is created where distance between the air molecules decreases. Such regions are called compressions (the region denoted by C in the figure) and a region of low pressure is called rarefactions (the region denoted by R in the figure). Sound travels through a medium forming alternating compressions and rarefactions. You have now understood that sound is a longitudinal wave.

Transverse Waves

Try an activity.

Fix a spring vertically on a table using a nail. Tie one end of a string to the top of the spring and the other end to a 50 g slotted weight. Pass the string through the pulley fixed at the end of the table as shown in the figure.

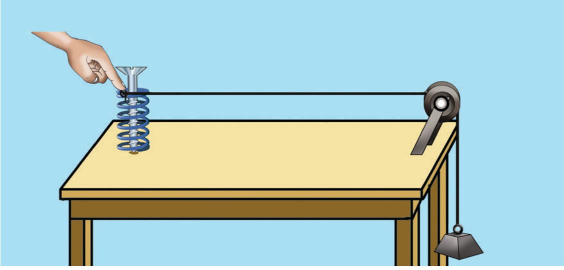


Fig. 1.10 (a)

Press and release the spring continuously. What do you observe?

- What is the direction of motion of the particles in the string, with respect to the equilibrium position? (parallel / perpendicular)
- Does each point on the string move parallel or perpendicular to the direction of propagation of the wave formed in the string?
- Do the particles on the string undergo resultant translatory motion other than moving vertically up and down from their equilibrium position?

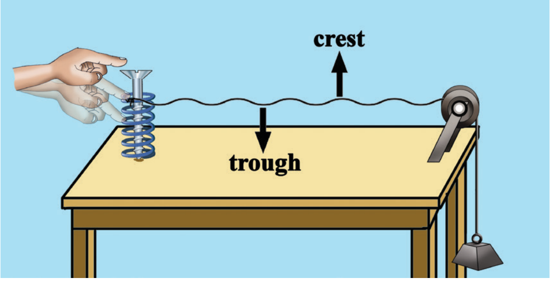


Fig. 1.10 (b)

When the particles of a medium vibrate perpendicular to the direction of propagation of the wave they are called transverse waves.

Observe the transverse waveform shown in figure 1.10 (b). In transverse waves, the elevated portions from the equilibrium position are called crests and the lowest portions from the equilibrium position are called troughs.

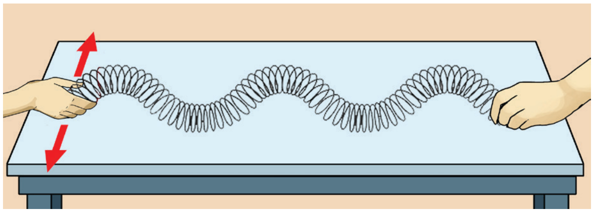


Fig. 1.10 (c)

Place a slinky on a table. Stretch both ends of it. Hold one end of the slinky and oscillate it as shown in figure 1.10 (c).

- Are the coils moving parallel or perpendicular to the waveform created on the slinky?
- What type of waveform is formed in the slinky?

Electromagnetic waves are transverse waves.

PhET→ Wave on a String

Some of the characteristics related to transverse waves and longitudinal waves are given below. Classify them and complete the table.

- Particles in the medium vibrate perpendicular to the direction of propagation of the wave.
- Compressions and rarefactions are formed.
- Pressure variations occur in the medium.
- Crests and troughs are formed.
- Particles in the medium vibrate parallel to the direction of propagation of the wave.
- No pressure variations occur in the medium.

Longitudinal waves	Transverse waves
• Particles in the medium vibrate parallel to the direction of propagation of the wave. •	• Particles in the medium vibrate perpendicular to the direction of propagation of the wave. •

Table 1.3

What are the features of waves?

Characteristics of Waves

The main characteristics of waves are :

- Amplitude
- Frequency
- Period
- Wavelength
- Speed of wave

Amplitude

The displacement-time graph of a particle in a wave is depicted.

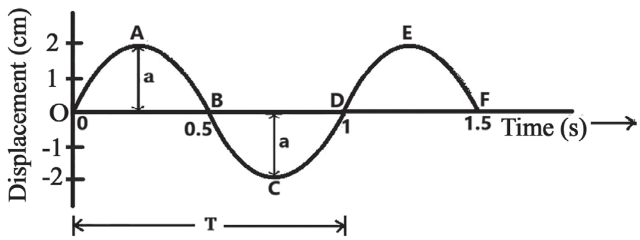


Fig. 1.11

- In the figure, which are the points with maximum displacement from the equilibrium position of the wave?

  (A, B, C, D, E)

- What is the amplitude of this wave?

Period

- In figure 1.11, what is the time taken by the particle in the medium to complete one vibration?
- What is the period of the wave in the figure?

Cycle

A cycle is one complete oscillation of a particle in wave motion.

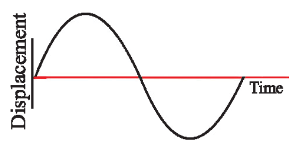


Fig. 1.12

Frequency

The frequency of a wave is the number of cycles that pass through a point in one second.

- If the wave shown in figure 1.11 takes 1 s to travel from O to D, find the frequency of the wave.

Wavelength

The state of the particles in a wave at a particular time is depicted in figure 1.13 (a).

Wavelength is the distance between two consecutive particles which are in the same phase of vibration. It is the distance travelled by the wave during the time taken by each particle in the medium to complete one vibration.

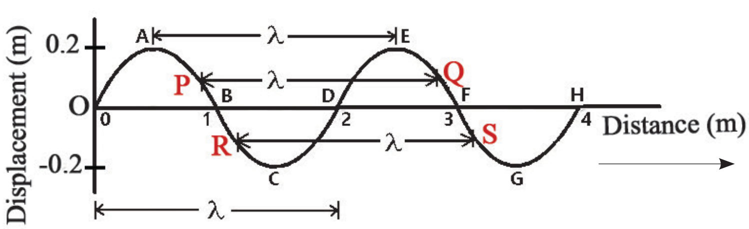


Fig. 1.13 (a)

The distance between two consecutive crests or two consecutive troughs is also considered as the wavelength of a transverse wave.

The Greek letter λ (lambda) is used to denote wavelength. The unit of wavelength is metre (m).

- In figure 1.13 (a), which particle is in the same phase of vibration as particle A? (B, C, D, E)
- In the case of particle P?
- In the case of particle B?
- In figure 1.13 (b), which represents the wavelength (λ)? (CR, RR)
- Here CR represents $(\lambda, \frac{\lambda}{2}, \frac{\lambda}{4})$

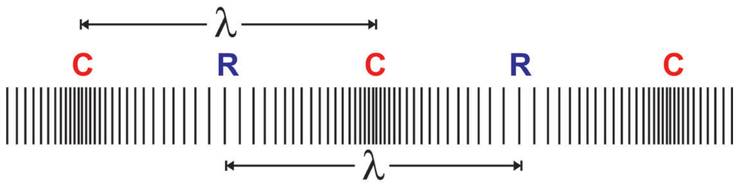


Fig. 1.13 (b)

The distance between two consecutive compressions or two consecutive rarefactions is considered as the wavelength of a longitudinal wave.

Speed of wave

The speed of a wave is the distance travelled by the wave in one second. The unit of speed of a wave is m/s.

- If a wave travels 700 m in 2 s, what is the speed of the wave?

Is there a relation between frequency and wavelength?

Place a slinky on a table. Stretch both ends of it. Hold one end of the slinky and oscillate it to produce a transverse waveform. Then increase the frequency of oscillation. Observe the change in frequency and wavelength of the waveform generated in the slinky.

If the frequency of the wave is changed, will the wavelength change?

An illustration of two waves of the same amplitude passing through a medium at the same time interval is given.

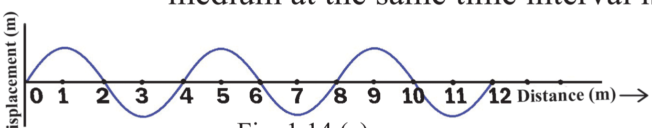


Fig. 1.14 (a)

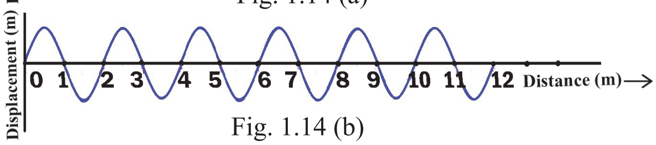


Fig. 1.14 (b)

- In figure 1.14 (a), what is the wavelength of the wave?
- What is the wavelength of the wave in figure 1.14 (b)?
- In figure 1.14 (a), if both the waves take 1 s to travel a distance of 12 m, what is the frequency of the wave?

- In figure 1.14 (b), what is the frequency of the wave?
- Which wave has a longer wavelength?
- Which wave has a higher frequency?
- What is the relation between wavelength and frequency?

The time taken by both the waves to travel a distance of 12 m is equal. So the speed of the wave will be equal.

When the speed is constant, frequency of the wave is inversely proportional to the wavelength. $f \propto \frac{1}{\lambda}$

The relation between the speed of wave, frequency and wavelength

Analyse figure 1.15 and answer the questions given below.

- What is the wavelength (λ)?
- If the wave takes 1 s to reach A from O, what is the frequency (f)?
- Isn't the speed of a wave the distance travelled by it in one second? What is the speed of the wave (v)?

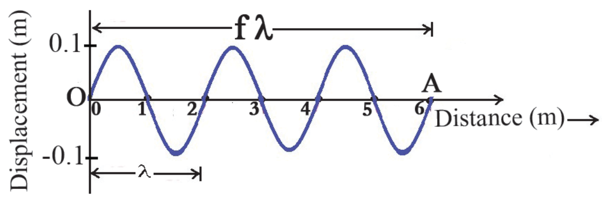


Fig.1.15

- Find the relation between wavelength, frequency and speed of a wave. It is found that the speed of a wave is the product of its wavelength and frequency.

Speed of a wave = frequency × wavelength

ie, $v = f\lambda$

The state of the particles in a wave at a particular time is depicted in the figure.

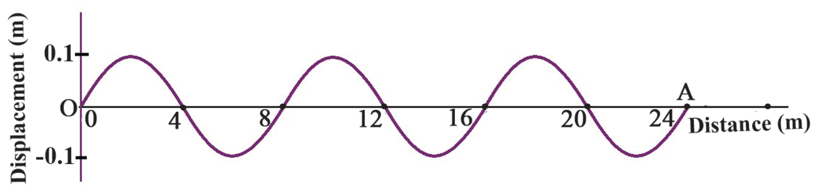


Fig.1.16

a) How many crests are there in the figure?

b) How many troughs are there?

c) What is the wavelength?

If the frequency of a longitudinal wave travelling at a speed of 350 m/s in the air is 35 Hz,

a) What is the distance between two consecutive compressions of this wave?

b) What about the distance between two consecutive rarefactions?

A sound wave with a frequency of 175 Hz has a wavelength of 2 m. Calculate the speed of sound.

Sound and light are waves. Light reflects. Can sound also reflect?

Reflection of Sound

Do sound waves reflect when they hit objects? Let's see.

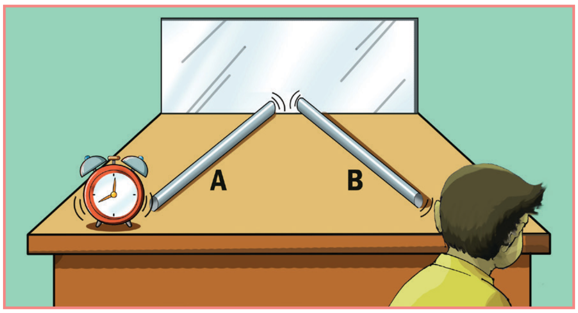


Fig. 1.17

Arrange two PVC pipes of 1 metre in length, a glass plate and an alarm clock as shown in the figure.

Adjust the pipe B at different angles and listen to the ticking sound from the clock. What could be the reason for the ticking sound being heard from the clock through the pipe B?

The sound is heard through the pipe B because sound waves reflect after striking the glass plate.

Repeat the experiment using rough surfaces instead of glass plate.

- Don't you feel a decrease in the loudness of the reflecting sound? What is the reason?

Smooth surfaces reflect sound more effectively than rough surfaces.

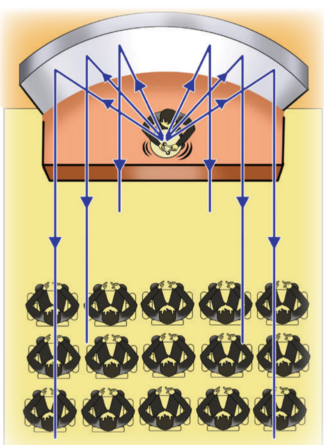


Fig. 1.18 (a)

Reflection of sound is utilised in :

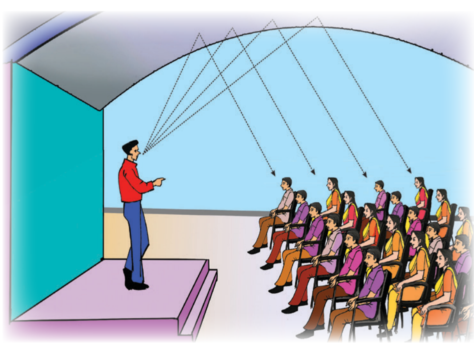


Fig. 1.18 (b)

- Soundboards [Fig.1.18 (a)]
- Curved ceilings in halls [Fig. 1.18 (b)]

These help to reflect sound from a source and spread it to all parts of the hall.

Multiple Reflection of Sound

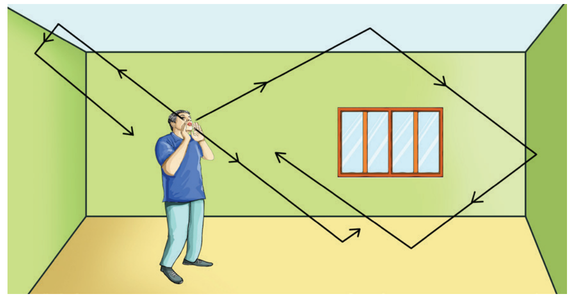


Fig. 1.19

The figure shows how sound from a source reaches a listener in a closed hall.

- Does sound from a source always travel directly to the listener?

Reflected sound waves get reflected again. This is multiple reflection of sound.

Are there instances when reflected sounds are heard distinctly?

Echo

Fig. 1.20

Have you ever had the experience of making a loud sound at the echo point and hearing the same sound again after a while?

While speaking loudly in a closed and empty large hall and calling or clapping loudly at a distance from a great mountain, isn't it possible to hear the same sound again after a while? This is possible due to the phenomenon of echo.

Echo is the sound heard after a while due to the reflection of the initial sound.

Why don't we hear echo inside a small room?

What should be the minimum distance from the listener to the reflecting surface, if the first sound is to be heard distinctly after reflection?

The auditory experience produced by a sound persists for about $\frac{1}{10}$ of a second. This characteristic is known as persistence of hearing. If another sound falls on the ear during this time, it is felt as if they are heard together.

- How long will it take to hear the echo distinctly after hearing the first sound?
- How far does the sound travel during this time?

(Consider the speed of sound in air as 350 m/s.)

$$\text{Distance} = \text{speed} \times \text{time}$$
$$= 350 \text{ m/s} \times \left(\frac{1}{10}\right) \text{s} = 35 \text{ m}$$

For the echo to be heard, the reflecting surface must be at least 17.5 m away, ie, half of 35 m. If the distance to the reflecting surface is more than 17.5 m, the same sound can be heard and distinguished again.

? The echo of fire cracker (kathina) is heard after 1 s by the person who burst it. How far is the reflecting surface from the person hearing the echo? (speed of sound in air is 350 m/s).

Let d be the distance to the reflecting surface. Then the total distance travelled by the sound to the reflecting surface and back will be 2d.

$$\text{Speed of sound} = \frac{\text{Total distance travelled}}{\text{Time}}$$
$$v = \frac{2d}{t}$$

$d = \frac{(v \times t)}{2} = \frac{(350 \times 1)\,m}{2} = 175$ m. **The reflecting surface will be 175 m away.**

? What should be the minimum distance between the source and the reflecting surface to hear the echo in water? (Consider the speed of sound in water as 1480 m/s)

If sound is made in an empty room, why is a boom felt?

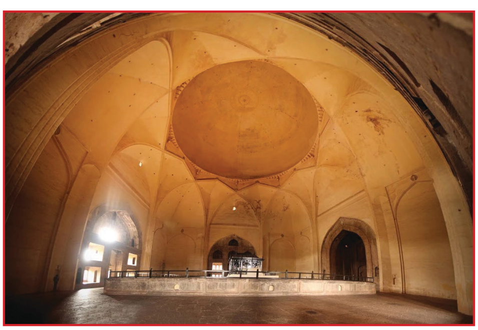


Fig. 1.21

Reverberation

Even if a small sound is produced inside the whispering gallery of Gol Gumbaz in Bijapur, Karnataka, it can be heard repeatedly throughout the gallery. This is due to the boom caused by the multiple reflections of sound waves on the spherical walls.

Reverberation is the lingering of sound, even after the original sound has ceased. It is due to the multiple reflection of sound and the boom fades away gradually.

Why are the walls of large halls like cinema theatres made rough?

Can a person with normal hearing ability hear all sounds?

Limits of audibility

Note the limits of frequency of sound audible to humans in figure 1.22.

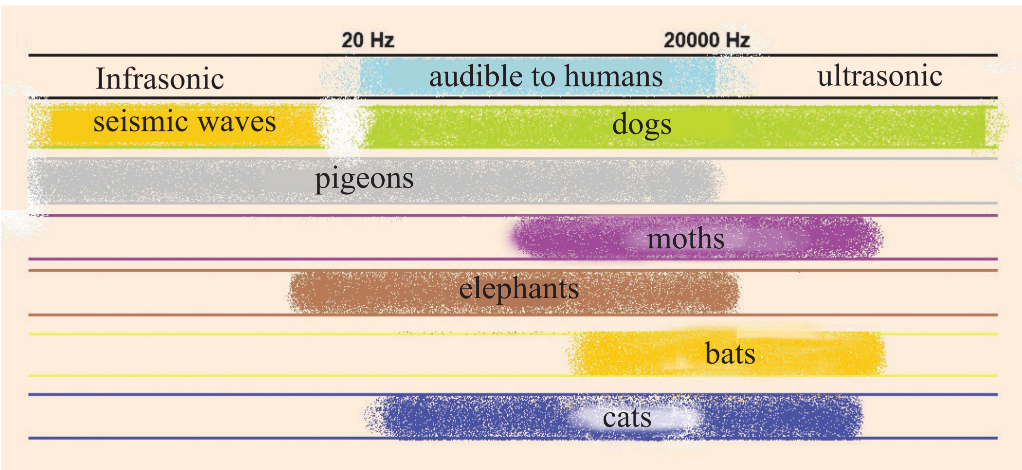


Fig. 1.22

The frequency of sound produced in a galton whistle used for training dogs is about 30000 Hz.

- Can humans hear the sound of a galton whistle?

Fig. 1.23

There are high and low-frequency sounds in nature. But humans cannot hear the sound of all frequencies. That is, there is a limit to the range of frequency of sounds that humans can hear. For a person with normal hearing, the lower limit of audible sound is about 20 Hz and the upper limit is about 20000 Hz (20 kHz). Sound with a frequency below 20 Hz is infrasonic. Sound with frequency more than 20000 Hz is ultrasonic.

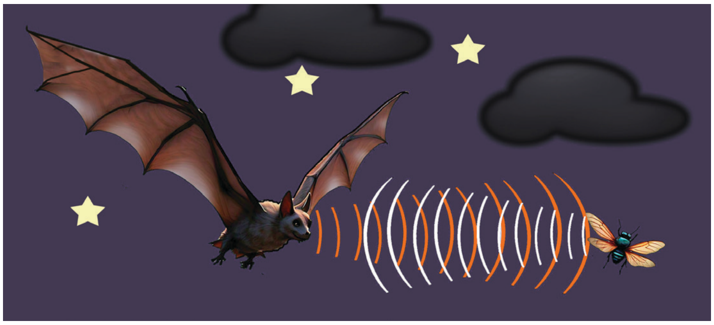


Fig. 1.24

Using ultrasonic sound, bats can travel smoothly and catch prey easily even in the dark. Ultrasonic waves are used in many situations.

Uses of Ultrasonic Waves


Fig. 1.25

In the medical field, ultrasonic waves are used for diagnosis and treatment.

- To crush small stones in the kidneys.
- In physiotherapy
- To take images of internal organs such as kidney, liver, gall bladder and uterus.

Ultrasonic waves that travel through body tissues strike and reflect at areas of varying density in the tissues. These waves are converted into electric signals to form an image of the organ (Fig. 1.25). This technique is ultra sonography.

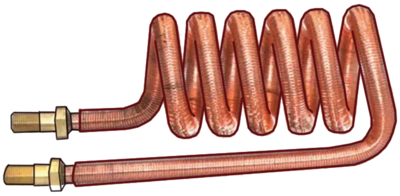


Fig. 1.26

- For cleaning spiral tubes, irregular machine parts, electronic components etc. (Fig. 1.26).
- In the device called SONAR which is used to find the distance to the underwater objects (Fig. 1.27).

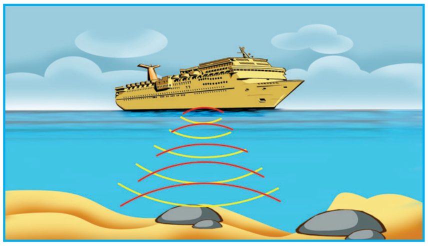


Fig. 1.27

If an ultrasonic wave emitted by a transmitter, installed on a ship on the surface of the water, strikes a rock at the bottom of the sea and returns after 0.2 s, what is the distance from the ship to the rock? Consider the speed of ultrasonic waves in seawater as 1522 m/s.

Can waves cause any harm?

You have understood the characteristics and uses of different types of waves. Any type of wave above a certain intensity can cause harmful effects. There are also destructive waves.

Seismic Waves and Tsunami

A building that was destroyed by the earthquake is seen in figure 1.28. Earthquakes often cause disaster.

Seismic waves are those which travel through the Earth's crust as a result of earthquakes, volcanic eruptions, and massive explosions. Seismology is the study of seismic waves. The intensity of earthquakes is determined by the Richter scale.

Fig. 1.28

Earthquakes that occur at the bottom of oceans or along coastal areas can sometimes trigger tsunami waves (Fig. 1.29). Tsunami is a series of gigantic ocean waves caused by the displacement of large volumes of water in the sea.

Fig. 1.29

- What measures can be taken to safeguard against tsunamis? Discuss and make notes.

Follow the instructions given by the official tsunami warning centres.

Let's Assess

1. Which of the following statements is correct?
   a) Sound and light are transverse waves.
   b) Sound and light are longitudinal waves.
   c) Sound is a longitudinal wave and light is a transverse wave.
   d) Sound is a transverse wave and light is a longitudinal wave.
2. The upper limit of frequency of sound that a bat can hear is 120 kHz. If so, what is the maximum wavelength of sound it can hear? Consider the speed of sound as 350 m/s.

3. A graphic illustration of two waves travelling at a speed of 3.2 m/s is given.

   a) Find out the frequency, period, and wavelength of each wave.

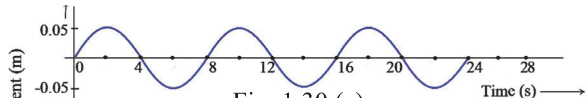


Fig. 1.30 (a)

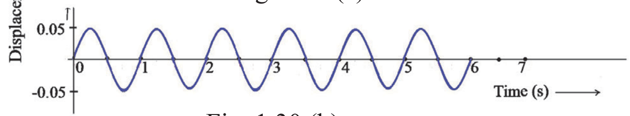


Fig. 1.30 (b)

4. Which of the following frequency can be heard by humans?
   a) 5 Hz b) 2000 Hz c) 200 kHz d) 50 kHz

5. A wave has a frequency of 2 kHz and a wavelength of 35 cm. How far does this wave travel in 0.5 s?

6. What is the frequency of a wave that produces 50 crests and 50 troughs in 0.5 s?

7. Which of the following is different regarding the waves given in the figures 1.31 (a) and 1.31 (b)?
   (frequency, amplitude, wavelength)

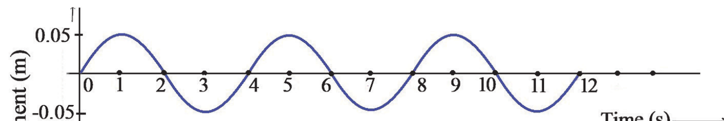


Fig. 1.31 (a)

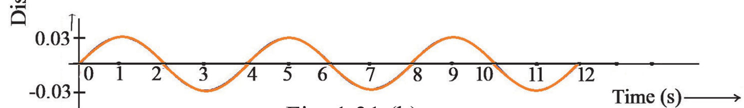


Fig. 1.31 (b)

8. The distance between two adjacent troughs of a transverse wave is 2 m. Find the frequency if its speed is 20 m/s.

9. When sound passes through a medium, …………….. travels.
   (the particles in the medium / the wave / the source of sound / the medium)

10. Two pith balls are suspended near the two prongs of a tuning fork fixed on a table so as to touch the prongs. A person plays a piano sitting near this system.
    a) In this case the pith balls move slightly. What is the reason?
       (forced vibration / echo)
    b) While playing certain notes on the piano, the pith balls are thrown to a maximum distance. Which phenomenon is responsible for this?
       (reverberation / resonance)

Extended activities

1. Plan an activity that illustrates the resonance of sound.

2. Prepare and present a seminar paper on the topic : 'Ultrasonic Waves and their Applications.'

2 Lenses

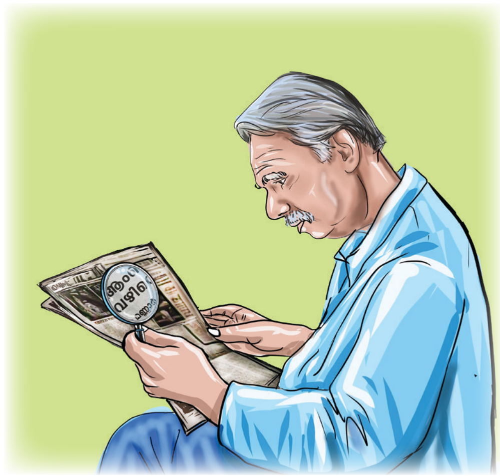


Fig. 2.1

Have you ever had such doubts?

Observe figure 2.1. Have you noticed older people using reading lens to make letters appear larger?

Where else are lenses used? Write them down.

- Toys
- Spectacles
- Door lens (lens fixed on the door to view the outside)
-

What makes these lenses different from a sheet of glass? Let's examine.

- Allow sunlight to fall on a paper through a thin sheet of glass. What is observed?

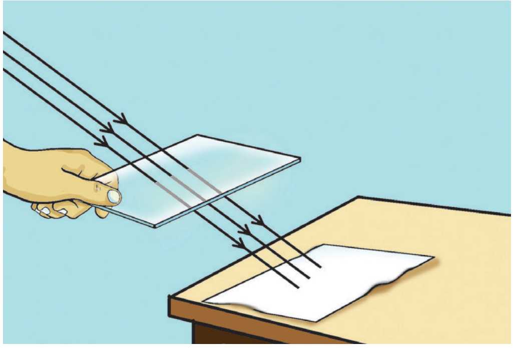


Fig. 2.2 (a)

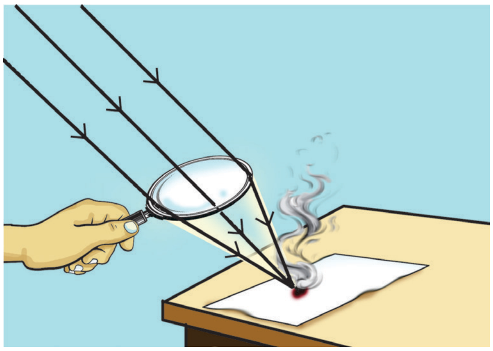


Fig. 2.2 (b)

- Vary the distance between the paper and the glass sheet. What do you observe?

It is seen that the size of the illuminated part does not change whether the glass sheet is near or far from the paper. Do the same activity using reading lens.

- What is your observation?

Note that when the lens is held at a specific distance from the paper, the size of the illuminated area is greatly reduced and the intensity of light at that area increases. Hold the lens at that point for a longer time. Can't you see the paper smouldering and catching fire?

What feature does the lens have that the glass sheet doesn't?

Convex lens and Concave lens


convex lens
Fig.2.3

Observe the lens used in the previous activity and note down its characteristics.

- Thicker in the middle
- Shows the objects magnified
-

The lens you are now familiar with is called convex lens. It is understood that such lenses can converge light rays.

Observe another type of lens (Fig 2.4). What are its features?

- Thinner in the middle
-

concave lens

Fig.2.4

Try to burn a piece of paper with such lenses. Is it possible?

It is understood that this type of lenses cannot converge light rays.

Such lenses are called concave lenses.

List the characteristics of concave lenses and convex lenses in the table.

Convex lens	Concave lens
• Thicker in the middle • •	• • Thicker at the edges •

Table 2.1

Observe the letters through each lens and move the lens to one side.

What is the observation?

- When a convex lens is used, the letters appear to move in the opposite direction.
-

This activity can be used as a method to distinguish between convex and concave lenses.

Observe figures 2.5 (a) and 2.5 (b).

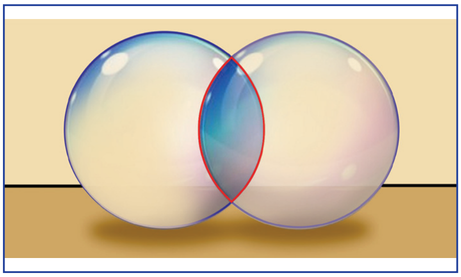


Fig. 2.5 (a)

Each lens has two surfaces. When light passes through them, refraction occurs. That means a lens has two refracting surfaces.

- Refracting surfaces of a lens are parts of (spheres / circles)

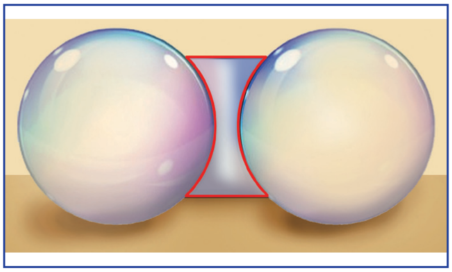


Fig. 2.5 (b)

A lens is a transparent medium in which each refracting surface is part of the spheres.

Terms Related to Lenses

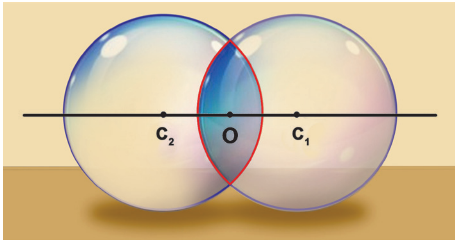


Fig. 2.6 (a)

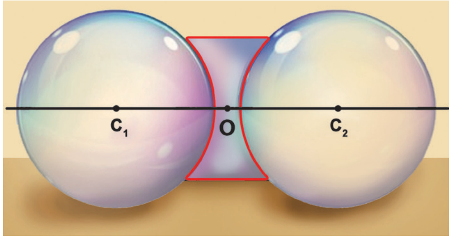


Fig. 2.6 (b)

- **Optic centre :** The midpoint of a lens is the optic centre (O).
- **Centres of curvature :** Each refracting surface of a lens is part of a sphere. The centres of such spheres are the centres of curvature.
- **Optic axis :** The optic axis is the imaginary line passing through the centres of curvature and the optic centre of a lens.
- **Aperture :** The area of the lens through which light passes is called aperture. In optical instruments such as cameras and microscopes, the aperture can be varied by using the stop.

Observe figures 2.6 (a) and 2.6 (b).

- Which figure represents convex lens? And which one represents concave lens?
- What do C_1 and C_2 indicate?
- Which refers to the optic centre? (C_1, O, C_2)
- Which represents the optic axis?

- **Principal focus**

Let's do an activity to find the principal foci of lenses.

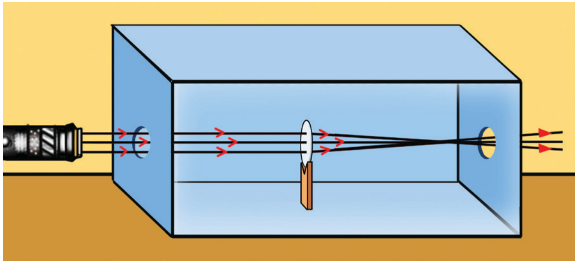


Fig 2.7

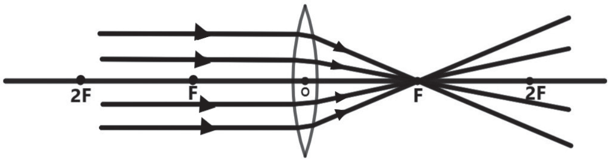


Fig 2.8

Materials : A box about 50 cm length, 30 cm width and 20 cm height, transparent on one side (a small hole should be made on the two opposite sides of the box and the holes should be sealed with a transparent sheet), laser torch (high beam type), incense stick, match box, convex lens, concave lens and lens stand.

After fixing the convex lens on the stand inside the box, fill the box with smoke. Allow light rays from the laser torch to pass through the hole and allow it to fall on the lens as shown in the figure.

- What do you observe?
- Depict the path of light

Haven't you noticed the change in the direction of light rays parallel to the optic axis of the convex lens as they pass through the lens? (It is to be noted that all light rays coming from a source or reflected from an object may not be parallel. But here we are considering only parallel rays). Haven't you seen light rays converge to a point on the other side of the lens after refraction? This point is the principal focus of the convex lens.

Light rays near and parallel to the optic axis incident on a convex lens, after refraction converge at a point on the optic axis on the other side of the lens. This point is the principal focus (F) of a convex lens.

Repeat the experiment shown in figure 2.7 by passing the light through the opposite hole. Didn't the light rays converge in this case too?

So such lenses have two principal foci, one on each side of the lens. These foci are equidistant from the optic centre.

The principal focus of a convex lens is considered real because light rays passing parallel to the optic axis of a convex lens pass through the principal focus, after refraction.

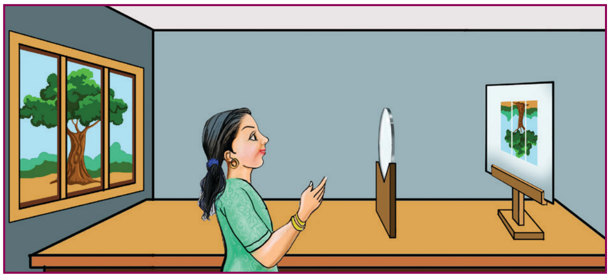


Fig 2.9

To find the approximate focal length of a convex lens, the distant object method can be used. Project the image of a distant tree or a building onto a screen using a convex lens. Measure the distance between the lens and the image using a scale. This distance is the approximate focal length of that lens.

Focal length

The focal length (f) is the distance from the optic centre of the lens to the principal focus.

Try smoke box experiment using a concave lens.

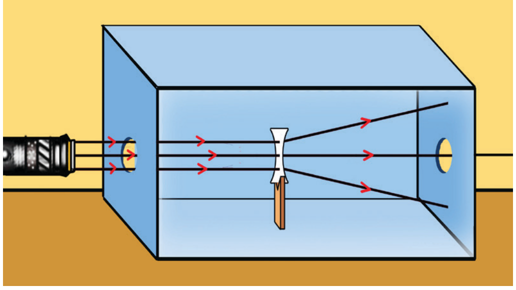


Fig. 2.10 (a)

Draw the path of the ray of light. Compare the figure drawn with figure 2.10 (a).

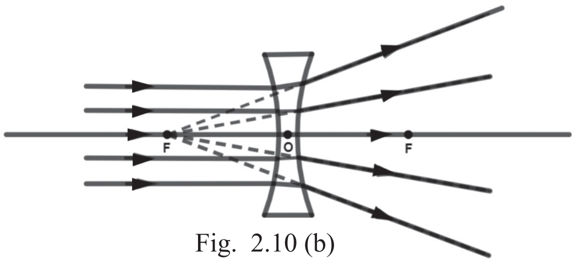


Fig. 2.10 (b)

Haven't you noticed the change in direction of the light rays passing parallel to the optic axis through the concave lens? Here the refracted rays appear to diverge from a point [Fig.2.10 (b)]. This point is the principal focus of the concave lens. A concave lens diverges the rays of light.

Light rays, near and parallel to the optic axis incident on a concave lens, after refraction appear to diverge from a point on the optic axis on the same side of the lens. This point is the principal focus of a concave lens (F).

Repeat the experiment by passing light through the other side of the concave lens. Haven't you understood that the concave lens also has two principal foci?

- Do refracted rays pass through the principal focus of a concave lens?
- If so, is the principal focus of a concave lens considered virtual or real?

Image Formation by Lenses

Project the image of a window onto a screen using a convex lens as shown in figure 2.11.

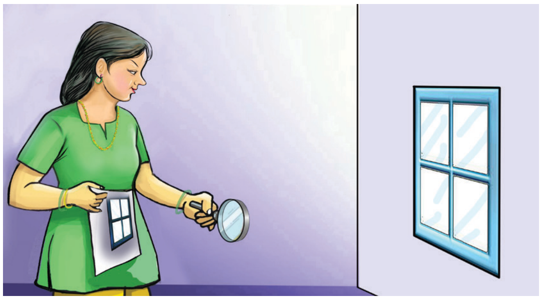


Fig. 2.11

- Try to form an image using a concave lens. Is it possible? Write down the results of the observation in the science diary.
- Which lens was used to form an image on the screen?

Images that can be projected on a screen are real images.

- Write down examples for real images.

➢ Image that is captured on a camera ➢ Image that is formed on a cinema screen

➢

Image Formation by a Convex Lens

Arrange a light source, the convex lens with pre-determined focal length, the lens stand and the screen as shown in the figure. Measure and mark F and 2F on the experiment table on both sides of the lens.

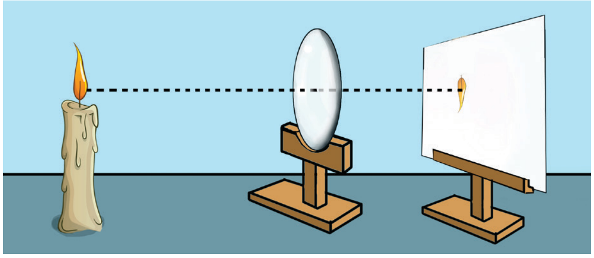


Fig. 2.12

Here we have to get the image of the object on the screen. Hence the light source is used as the object in this experiment.

First place the object (light source) beyond 2F and adjust the position of the screen to get a clear image. Observe the features of the image and record them in the table given below.

Record the positions and properties of the image in the table by placing the object at various positions in table 2.2.

Position of the object	Position of the image	Characteristics of the image
Beyond 2F	Between F and 2F	Diminished, inverted, real
At 2F		
Between F and 2F		
At F	At infinity (Far away)	Magnified, inverted, real
Between F and lens		

Table 2.2

Ray Diagram of the Image Formation by a Convex Lens

Let's draw the path of light rays from an object placed in front of a convex lens as they pass through the lens.

Observe figure 2.13 (a) (b) and (c). Write down in table 2.3 the details of the path of light rays passing through the convex lens through different paths from point A.

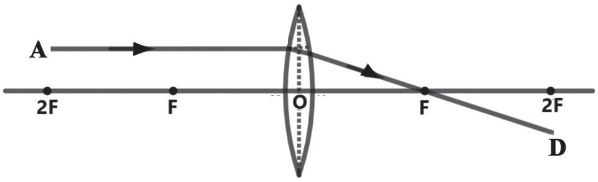


Fig. 2.13 (a)

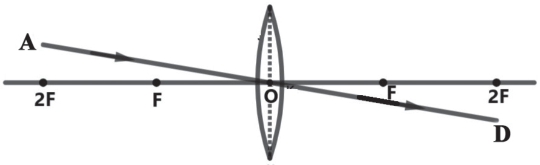


Fig. 2.13 (b)

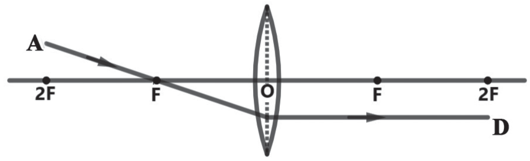


Fig. 2.13 (c)

A ray of light from a point which is parallel to the optic axis incident on a convex lens	Passes through the principal focus on the other side.
A ray of light passing through the optic centre	
A ray of light after passing through the focus on the same side of the object incident on the lens	

Table 2.3

A ray of light coming from a point on an object and passing through any point of the lens follows the laws of refraction.

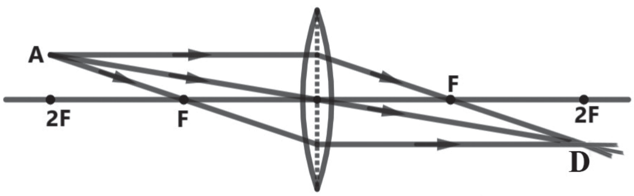


Fig. 2.14

After observing figure 2.14, haven't you seen that the light rays which have taken different paths pass through a single point?

Hence the image of A is formed at D. Similarly, the image of any point on the object is formed at the point of convergence of refracted light rays originating from the corresponding points.

If a screen is placed at the point of convergence of the refracted rays, the image is formed there.

Complete the ray diagram of the formation of image when the object is placed at different positions. Find the position and characteristics of the images.

Object beyond 2F

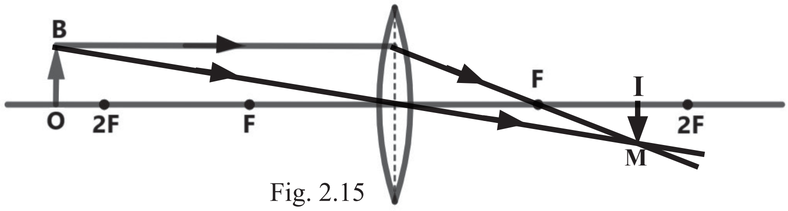


Fig. 2.15

- Position of the image : Between F and 2F on the other side
- Characteristics of the image :
  - Inverted
  - Diminished
  - Real

Object at 2F

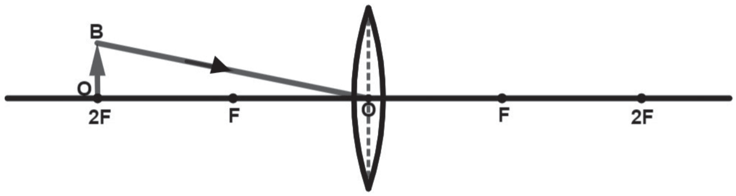
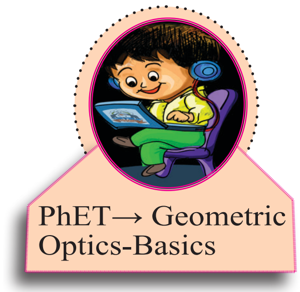


Fig. 2.16



- Position of the image :
- Characteristics of the image :
  - ➢

Object Between F and 2F

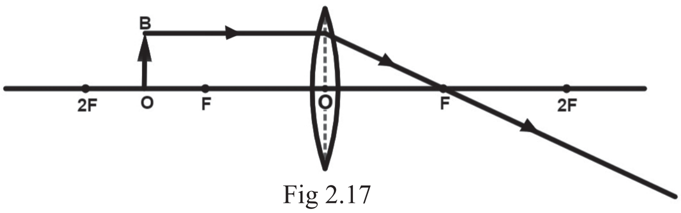


Fig 2.17

- Position of the image:
- Characteristics of the image :
  - ➢

Object at F

Draw the ray diagram of the image formation.

- Do refracted rays converge?
- What would be the characteristics of the image?

Compare it with the experiment done earlier.

Does a convex lens always form only real images?

Object between F and the Lens

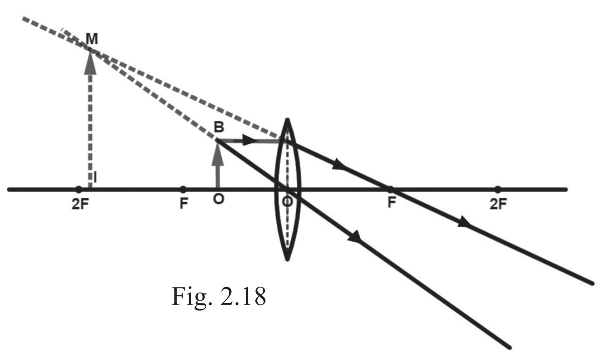


Fig. 2.18

Observe the ray diagram of the image formation when the object is placed between the focus (F) and the optic centre (O).

- Position of the image : On the same side of the object
- Characteristics of the image :
  - ➢ Erect
  - ➢ Virtual
  - ➢

- Here, do the light rays coming from the object and passing through the lens pass through a common point?

Aren't the light rays coming from the object diverging? When we observe this object from the other side of the lens, we can see the magnified image of the object.

Thus the image that cannot be obtained on the screen, but can only be seen, is virtual.

Images that cannot be captured on a screen, but can only be seen are virtual images.

Image Formation by a Concave Lens

We have seen how to form an image using a convex lens. Similarly try to form an image using a concave lens. What is your finding?

Ray diagram of image formation by concave lens

Complete table 2.4 by observing the change in the path of light as it passes through a concave lens.

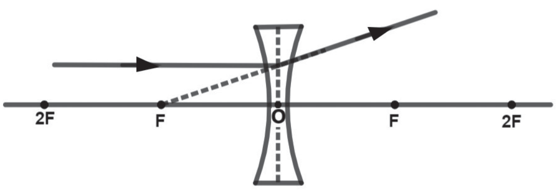


Fig. 2.19 (a)

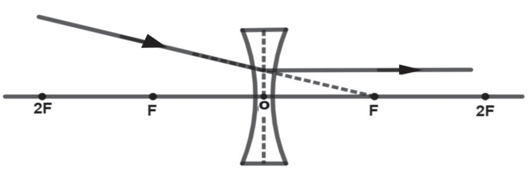


Fig. 2.19 (b)

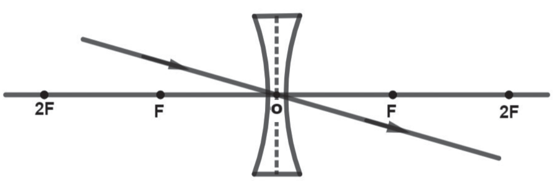


Fig. 2.19 (c)

Rays of light parallel to the optic axis incident on a concave lens (after refraction)	
Light rays passing through the lens directed towards the principal focus on the other side (after refraction)	
Rays of light passing through the optic centre	

Table 2.4

Object between F and 2F

- Position of the image :
- Characteristics of the image :

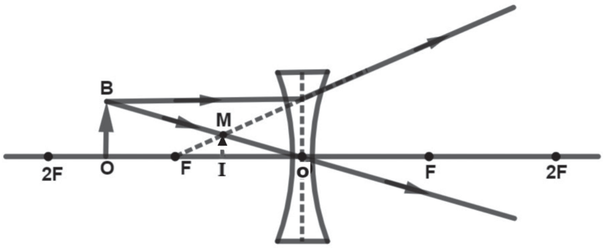


Fig. 2.20

Object between F and Lens

An object is placed between F and the lens. Draw the ray diagram of the image formation in the science diary.

- Position of the image :
- Characteristics of the image:

Complete the given table based on the image formation by a concave lens.

Position of the object	Position of the image	Characteristics of the image		
		Real/ Virtual	Inverted/ Erect	Magnified/ diminished
Between F and 2F				
Between F and the Lens				

Table 2.5

On analysing table 2.5, it is understood that the image formed by a concave lens is virtual. What could be the reason for this?

As concave lens diverges light rays, the image it forms is always virtual. The position of the image is always between F and the lens on the same side of the object.

Can we calculate how far the image from the lens will be, if an object is placed at a given distance?

Lens Equation

With regard to the image formation by a lens, we consider the focal length, the distance from the optic centre to the object and to the image.

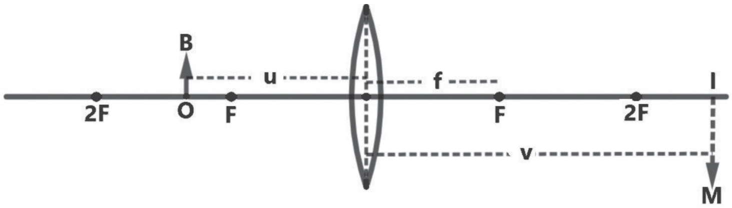


Fig. 2.21

Observe these distances marked in the figure.

- Which letter indicates the distance to the object (OB) in the figure?
- Which distance does the letter v represent in the figure?
- Which distance does the letter f stand for?

As the lenses and positions of the object change, appropriate signs for the measurements related to the lens should be considered.

Cartesian sign convention

While solving mathematical problems related to lens, appropriate signs should be given for the measurements. These rules can be used in lenses in general.

- All distances should be measured from the optic centre of the lens.
- Distances measured in the same direction as the incident ray should be considered positive and those in the opposite direction should be considered negative.
- Distances measured above the optic axis should be considered positive and those below should be considered negative.

Cartesian sign convention can be used to solve mathematical problems using general equations in different contexts. There is no need to consider whether the object is on the left or right side of the lens. Observe figures 2.22 (a) and (b) and complete table 2.6 based on Cartesian sign convention.

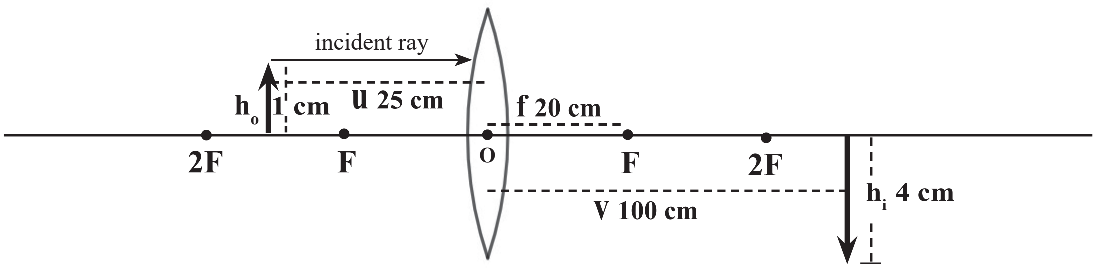


Fig 2.22 (a)

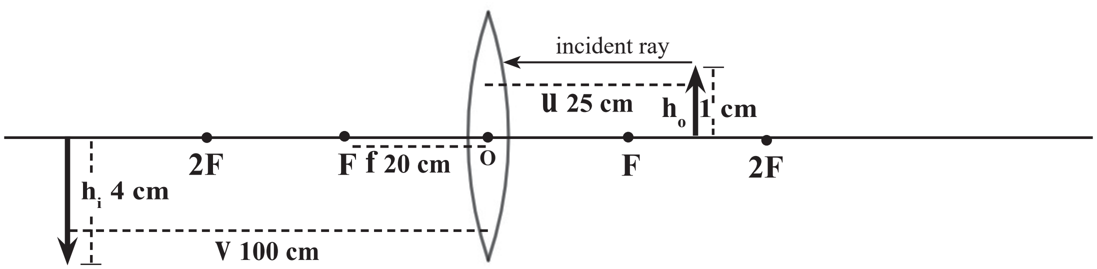


Fig 2.22 (b)

Measurements	Fig. 2.22 (a)		Fig. 2.22 (b)	
	Positive/ negative	Reason	Positive/ negative	Reason
u	negative (-25 cm)	measured from the optic centre in the opposite direction of the incident ray	negative (-25 cm)	measured from the optic centre in the opposite direction of the incident ray
v				
f				
h_o				
h_i				

Table 2.6

The position of the image formed by a lens is determined by the position of the object and the focal length of the lens. The relation between them is made clear by the lens equation.

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

f = focal length; u = distance to the object; v = distance to the image

This equation can also be written as

$$f = \frac{uv}{u-v}$$

- Observe the distance to the object and the distance to the image depicted in the figure.

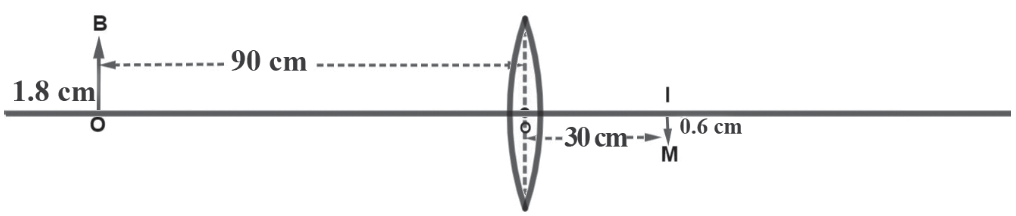


Fig 2.23

a) Write down the measurements using the sign conventions.

b) Calculate the focal length of the lens.

a) Distance to the object, u = − 90 cm (measurement in a direction opposite to that of the incident ray)

Distance to the image, v = + 30 cm (measurement in the same direction as that of the incident ray)

b) $f = \frac{uv}{u-v}$

$$f = \frac{-90\text{ cm} \times {}^{+}30\text{ cm}}{-90\text{ cm} - {}^{+}30\text{ cm}} = \frac{-2700\text{ cm}^2}{-120\text{ cm}} = +22.5\text{ cm}$$

Since the focal length is positive, it can be understood that the principal focus is real and the lens used here is convex.

Is it possible to find how many times the size of the image is to the size of the object?

Magnification

Magnification refers to how many times the height of the object is to the height of the image.

Magnification is the ratio of the height of the image to the height of the object. It has no unit.

$$\text{Magnification} = \frac{\text{Height of the image}}{\text{Height of the object}} = \frac{h_i}{h_o}$$

OR

$$\text{Magnification} = \frac{\text{Distance to the image}}{\text{Distance to the object}} = \frac{v}{u}$$

$$\mathbf{m = \frac{h_i}{h_o} = \frac{v}{u}}$$

According to Cartesian sign convention, it can be understood that the image is erect if magnification is positive and the image is inverted if magnification is negative.

Calculate the magnification using the measurements in the figure 2.23 and write down the characteristics.

$$m = \frac{h_i}{h_o} \quad \text{or} \quad m = \frac{v}{u}$$

$u = -90$ cm $\quad h_o = +1.8$ cm $\quad v = +30$ cm $\quad h_i = -0.6$ cm

$$m = \frac{h_i}{h_o} = \frac{-0.6}{+1.8} = -\frac{1}{3}$$

$$m = \frac{v}{u} = \frac{+30}{-90} = -\frac{1}{3}$$

Since magnification is less than one, it can be understood that the image is smaller than the object.

The negative sign of the magnification indicates that the image is inverted and real.

Complete table 2.7 by considering the relation of magnification with the nature of the image.

Nature of the image	Sign of magnification (positive / negative)
Erect	
Inverted	
Real	
Virtual	

Table 2.7

An object of height 2 cm is placed on the optic axis at a distance of 12 cm from the optic centre of a convex lens. Focal length of the convex lens is 6 cm.

a) Draw a ray diagram based on the given measurements and write down the characteristics of the image.

b) Calculate the magnification by measuring the height of the image.

A concave lens has a focal length of 20 cm. An object of height 2 cm is placed at a distance 30 cm from the lens on the optic axis.

a) Calculate the distance from the lens to the image.

b) How much will the magnification be? What are the characteristics of the image?

Which are the instruments where lenses are used?

The position, nature and size of the images formed by different types of lenses have been found out. Some of the instruments that make use of these are :

Spectacles, simple microscope, compound microscope and telescope.

Have you noticed the prescriptions given by doctors to buy spectacles? Can you identify what is written on it?

- What does +2.00 refer to?

It refers to the power of the lens in the spectacles.

Dr.Brook Pettre
MBBS, DO M.S-Ophthalmology

Rx	SPH	CYL	AXIS	VN	PD
R.E.	+2.00	+0.50	130	6/6	-
L.E.	+2.00	+0.50	140	6/6	-

Remarks : Bptre

Fig 2.24

Power of Lens

Power is a term related to the focal length of the lens. The power of a lens is its ability to converge or diverge light rays incident on it.

Power is the reciprocal of focal length. The lower the focal length, the higher the power of the lens. Power $P = \frac{1}{f}$

The SI unit of power is dioptre. It is denoted by the letter D.

The power of a lens with a focal length of one metre is one dioptre (1 D).

What is the power of a concave lens of focal length 25 cm?

Focal length of concave lens = – 25 cm

Since the focal length is considered in metre while calculating the power of the lens in the SI unit,

$$f = \frac{-25}{100} \text{ m} = -0.25 \text{ m}$$

Power $P = \frac{1}{f}$

$$P = \frac{1}{-0.25 \text{ m}} = -4 \text{ D}$$

If the power is negative, it is identified as concave lens.

- If it is a convex lens, what will be the sign of the power?
- What type of lens is in the doctor's prescription (Fig. 2.24)?

Let's take a look at some of the devices that use lenses.

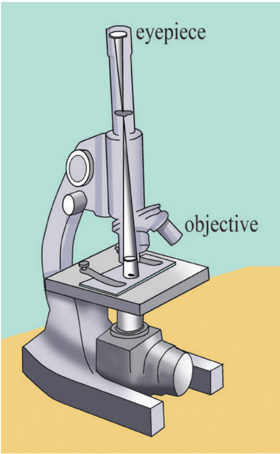


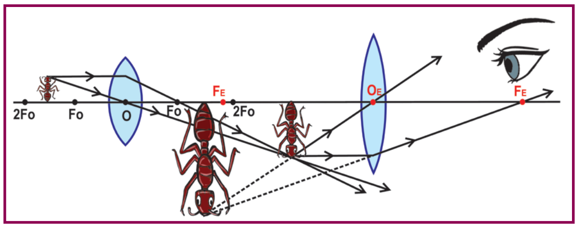
Fig. 2.25 (a)

Compound Microscope

What is the use of a compound microscope?

Have you ever wondered how they magnify objects?

The two main parts of a compound microscope are objective and eyepiece.



Magnification is not according to the scale
Fig. 2.25 (b)

Objective :

An objective is a lens placed close to the object to be observed.

Eyepiece :

Eyepiece is the lens through which the image formed by the objective lens is observed. The focal length of the eyepiece is greater than that of the objective.

Observe figure 2.25 (b) and complete table 2.8 identifying the characteristics of lenses used in compound microscope.

Lens	Convex lens / Concave lens	When objective and eyepiece lenses are compared focal length more / less	Characteristics of the image formed
Objective			
Eyepiece			

Table 2.8

- Where should the object to be observed be kept with reference to the objective?
  (beyond $2F_O$ / between F_O and $2F_O$)
- What is the position of the image formed by the objective?
- What are the characteristics of this image?
- What would be the characteristics of the image formed by the eye piece?
  - Erect
  -

The object should be placed between F_O and $2F_O$ of the objective. A large, real, inverted image of the object is formed beyond $2F_O$ of the objective. This acts as the object for the eyepiece. Its position is between the optic centre and F_e of the eyepiece. A large and virtual image of this can be seen through the eyepiece.

- Increasing the focal length of the objective lens will not be beneficial in the compound microscope. What is the reason?

If the focal length of the objective lens is longer, the size of image will be smaller. That means the magnification will be lesser. So the objective lens should have a shorter focal length.

A microscope is usually provided with a range of objective lenses to obtain suitable magnification while observing micro objects.

Refracting Telescope

Telescopes are instruments to see distant objects clearly. The invention of the telescope brought about a great change in the study of the universe. There are different types of telescopes that make use of reflection and refraction of light. Let us see the functioning of a telescope whose working is based on the refraction of light.

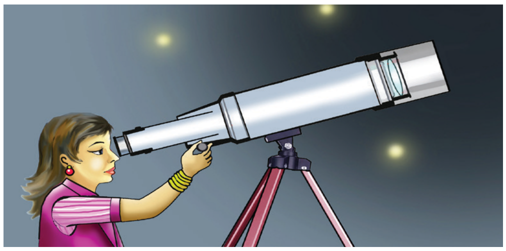


Fig 2.26 (a)

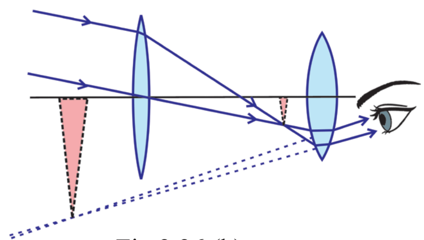


Fig 2.26 (b)

Observe figures 2.26 (a) and 2.26 (b).

The main parts of the telescope are objective and eyepiece. Identify their characteristics and complete the table given below.

Lens	When objective and eyepiece lenses are compared		Characteristics of the image formed
	focal length more / less	aperture more / less	
Objective			
Eyepiece			

Table 2.9

Let's see how the image is formed in the telescope.

- Where is the position of the object?
  (far away / nearby)

- Focal length of the objective is (lesser / greater)
- What are the characteristics of the image formed by the objective? (small and real / large and virtual)
- Which of the lenses use this image as its object? (objective / eyepiece)
- Through which lens is the image viewed? (objective / eyepiece)
- The image we see through the eyepiece is (real / virtual)

In a telescope, the objective forms a small, real and inverted image of a distant object.

It is the image formed by the objective that we observe through the eyepiece. Since the position of this image is between the focus of the eyepiece and the optic centre, we can see the virtual image formed by the eyepiece.

It is clear that while making a telescope, the length of the telescope tube should be taken by considering the focal length of the objective lens and the focal length of the eyepiece lens.

Now haven't you understood how distant objects can be seen clearly in a telescope?

Let's make a telescope.

Making a Telescope

Materials required

Approximately 1 m long PVC pipe (having a diameter suitable enough to fix the lens), convex lens (of diameter 5 cm /10 cm and focal length 50 cm /100 cm), plastic bottle, eyepiece used for watch repair.

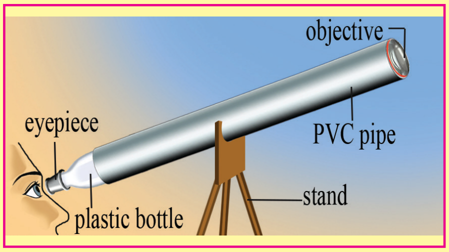


Fig. 2.27

Things to be considered while choosing lenses :

- The focal length and aperture of the objective lens should be greater.
- The focal length and aperture of the eyepiece lens should be lesser.
- Use high quality lenses.

Method of Construction

Fix a convex lens of approximately 10 cm diameter and focal length 100 cm at one end of a PVC pipe having approximately 10 cm diameter. Cut the bottom of a plastic bottle of two litre and insert it into the other end of the pipe. Insert and fix the eyepiece (used for watch repair) at the mouth of the plastic bottle. Distant objects can be observed by adjusting the distance between the eye piece and the objective by pushing or pulling the plastic bottle.

Special Attention

Do not look at the sun through a telescope. It is preferable to fix a telescope on a stand while observing other celestial bodies.

- Why is it said not to look at the sun through a telescope? Search and find out.

Let's Assess

1. The focal length of a convex lens is 20 cm. An object of height 3 cm is located at a distance of 60 cm from its optic centre on the optic axis.
   a) Calculate the height of the image.
   b) What are the characteristics of the image obtained?
2. The focal length of a lens is 20 cm.
   a) An object is placed 30 cm away from the lens. Calculate how far the screen should be placed to get a clear image.
   b) If the height of the object is 1.2 cm, what will be the height of the image appearing on the screen?
3. The focal length of a convex lens is 100 mm. An object of height 15 mm is located 60 mm from the optic centre on its optic axis.
   a) Draw its ray diagram on a graph paper and find the position and height of the image.
   b) Calculate the magnification if the distance to the object is 20 mm.

4. Four statements are given regarding the image formed by a concave lens. Find and choose the correct answer.

   i. It will be diminished and inverted

   ii. It will be diminished and virtual

   iii. It will be magnified and virtual

   iv. It will be diminished and erect

      a) Only the second statement is true

      b) Only the first statement is true

      c) Second statement and fourth statements are true

      d) Only the third statement is true

5. A concave lens has a focal length of 50 cm. What will be its power?

   a) +2 D b) +0.5 D c) −2 D d) −0.5 D

6. Find the most appropriate statement related to a telescope.

   a) The objective lens has a shorter focal length and the eyepiece lens has a longer focal length.

   b) The objective lens has a longer focal length and the eyepiece has a shorter focal length.

   c) Objective lens and eyepiece lens are concave lenses.

   d) Objective lens will be concave lens and eyepiece lens will be convex lens.

7. When an object is placed in front of a lens, the image formed is inverted.

   a) Is it real or virtual?

   b) What will you do if you want another image of this obtained image to be real, erect and of the same size?

8. When an object is placed at the principal focus of a lens, an image that is erect and diminished is obtained.

   a) What kind of lens is this?

   b) Draw the ray diagram of the image formation.

9. The image (IM) obtained when an object is placed in front of a lens is depicted.

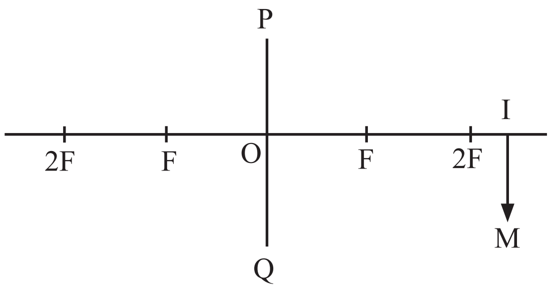


Fig. 2.28

a) If PQ is a lens in the figure, what type of lens does PQ represent?

b) Complete the ray diagram and find the position of the object.

c) The height of the object is .... than the height of the image (greater / lesser).

10. Match the items in the columns A, B and C appropriately.

A	B	C
Magnification	$\frac{1}{f}$	h_i negative
Power of lens	Inverted image	$\frac{v}{u}$
Real image	$\frac{h_i}{h_o}$	h_i positive
	Erect image	dioptre

Table 2.10

Extended activities

1. You may know people who use spectacles for various purposes. Collect, tabulate and analyse information regarding the type of lens used in different types of spectacles, the power of lens, age of the users and the problems faced by them.

2. Collect a transparent polythene bag. Fill it with water and tie to get it almost in the shape of a sphere. Use it as a convex lens to form various sized images of a burning candle.

3 The World of Colours and Vision

Have you ever thought about the reason why flowers appear in different colours, though they are all illuminated by the same light?

Refraction through a Glass Prism

Pass a beam of light from a laser torch through a prism as shown in figure 3.1.

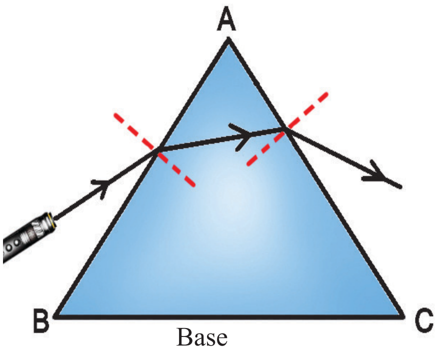


Fig.3.1

Have you observed the deviation in the path of light?

- What is the reason for this deviation?
- Identify the faces on which the light ray undergoes deviation. Depict the path of light ray in your science diary.
- Towards which part of the prism does the light ray deviate when it enters into the prism from air?
- What about when the light ray passes from the prism into air?

When light ray enters and leaves a prism, it deviates towards the base of the prism due to refraction.

Dispersion of Light

Let's pass sunlight through a prism instead of laser light.

Using a plane mirror, reflect sunlight onto a white wall. Place a narrow slit in the path of the sunlight so that only a thin beam of light passes through it.

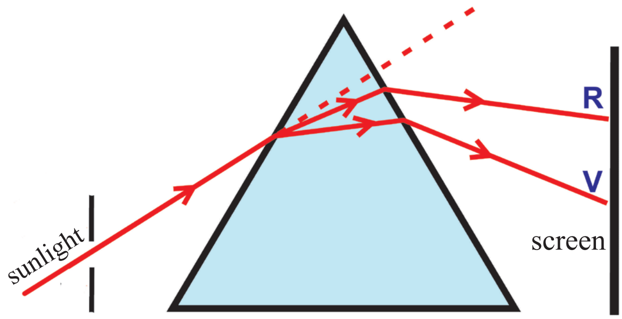


Fig. 3.2

Now you can see a white patch of light on the wall.

Arrange a prism in the path of this beam so that it falls obliquely on one of its sides (Fig. 3.2).

- What do you observe?
- Instead of white light, don't you see different colours as in a rainbow on the wall?

You have seen that sunlight splits into different colours. Record in the science diary the colours in the decreasing order of deviation. Can't you see the component colours in the order violet, indigo, blue, green, yellow, orange and red (VIBGYOR)? This orderly arrangement of the component colours in white light is called the spectrum.

Fig. 3.3

Why does sunlight split into its component colours when it passes through a prism?

Observe the splitting of sunlight into its component colours when it passes through a prism as shown in figure 3.4.

- What could be the reason for the deviation of the light ray?

When light ray passes through a prism, it deviates at the two faces due to refraction.

- Is this deviation the same for all the colours?

Let's see how this is related to the wavelength of different colours of light.

Compare the wavelengths of the colours given in table 3.1.

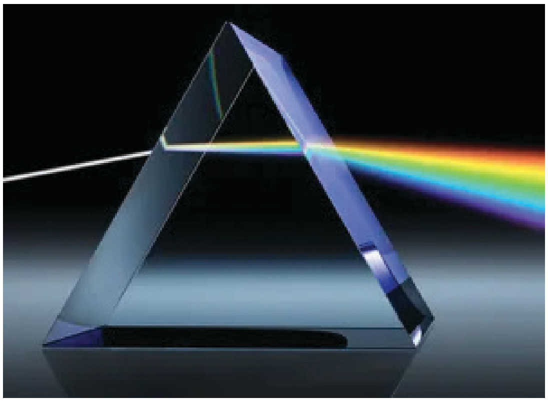


Fig. 3.4

Colour	Approximate wavelength (nanometre) nm
Violet (V)	380 - 440
Indigo (I)	440 - 460
Blue (B)	460 - 500
Green (G)	500 - 570
Yellow (Y)	570 - 590
Orange (O)	590 - 620
Red (R)	620 - 750

Table 3.1

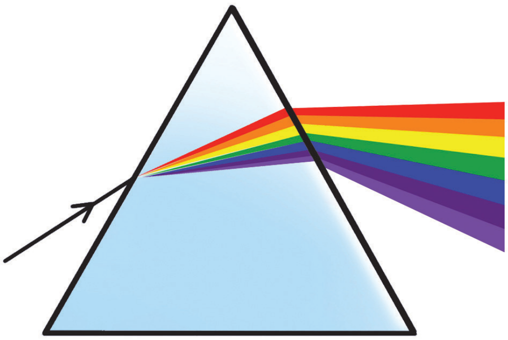


Fig. 3.5

- Which colour of light has the shortest wavelength? Which has the longest?
- Which colour deviates the most as it passes through a prism? Which has the least deviation?
- What is the reason for the changes observed in the deviation of colours?

Compare the deviation of colours with their wavelengths.

- How does the deviation of colours change with the increase in the wavelength as it passes through a prism?
- What are the factors on which the deviation of a ray of light depend?
  - ➢ Refractive index of the medium
  - ➢ Wavelength of the colour of light

When light passes through a glass prism, it undergoes refraction at the two refracting faces of the prism. The extent of deviation depends on the wavelength of light. Red deviates the least because of its longer wavelength. What about violet, which has a shorter wavelength? What about the other colours? The wavelength of other colours lie in between red and violet. Hence their deviation occurs proportionally and is arranged between red and violet.

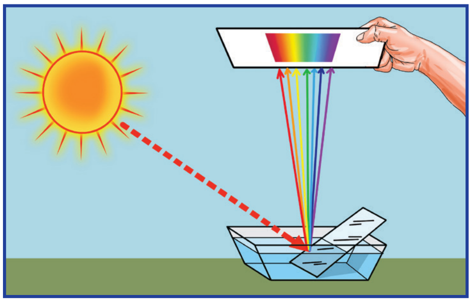


Fig. 3.6

Place a small plane mirror slightly inclined in a tray of water as shown in the figure. Adjust its position so as to reflect sunlight onto a screen. What do you observe? Explain based on the dispersion of light.

From the experiments we have done, we can understand that sunlight is composed of different colours.

Light composed of different colours is a composite light.

Dispersion of light is the phenomenon of splitting up of a composite light into its component colours.

Is the rainbow seen in the sky formed by dispersion?

Rainbow

Have you observed a rainbow? Can we create a rainbow artificially?

Fig. 3.7

Spray fine droplets of water into the air when the sun is shining behind you. What do you observe? Haven't you created an artificial rainbow? Compare the spectrum obtained now with the colours of the natural rainbow. Identify the colours you have observed. Note them down in the science diary. Now spray fine droplets of water towards the sun. A rainbow is not formed, is it? A rainbow is always formed in a direction opposite to the sun. Where will the Sun be when a rainbow is seen in the east? What about the position of the Sun when a rainbow is seen in the west?

How is a rainbow formed in the sky?

Observe figure 3.8.

- When passing through water droplets where do light rays undergo refraction?
- What happens to the refracted light rays inside the water droplets?

A ray of sunlight passing through a water droplet undergoes refraction twice and internal reflection once. This is a natural phenomenon. A rainbow is formed as a result of the combined effect of refraction, dispersion, and internal reflection.

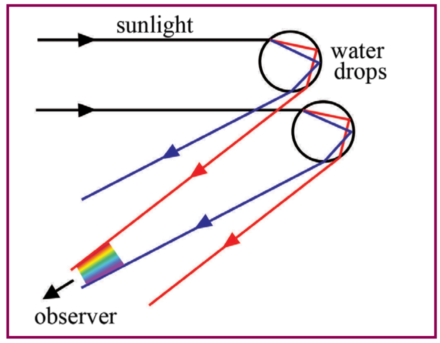


Fig. 3.8

Recombination of Colours of Light

We get dispersed light from the prism in the experiment as shown in figure 3.2. In the path of the dispersed light arrange an identical prism as shown in figure 3.9.

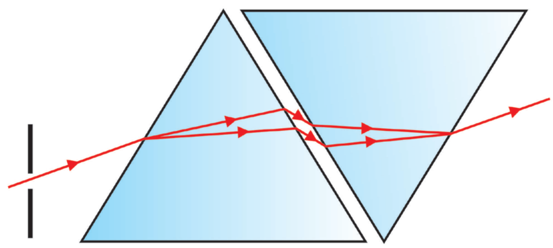


Fig. 3.9

- What kind of light is obtained on the wall? (coloured light / white light)
- What could be the reason for this?

The rays of different colours from the first prism undergo a deviation in the opposite direction by the second prism. This results in the recombination of colours to produce white light on the wall.

Are there any other components in sunlight besides visible light?

Electromagnetic Spectrum

We feel hot when sunlight falls on our body. Sunlight is beneficial to our body. But do you know that excessive exposure to sunlight is harmful? What could be the reason for this?

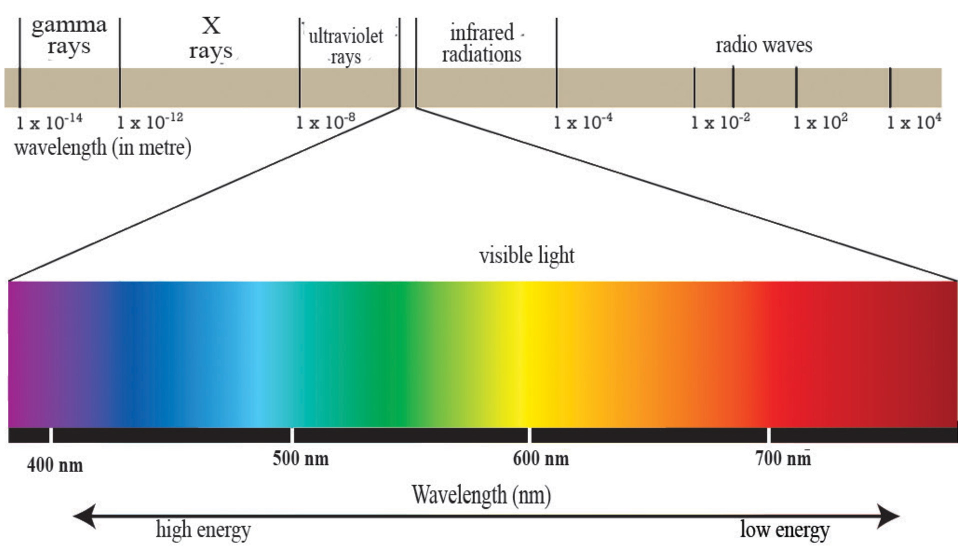
Sunlight contains infrared and ultraviolet radiations in addition to visible light. The infrared radiation in the sunlight is the main reason for the heat in the Sun's rays.

In the activity shown in figure 2.2 (b) (burning paper using a lens), the paper burns because of the convergence of infrared radiation on the paper. Ultraviolet radiation helps to produce vitamin D in our body.

Solar radiations reach the earth's atmosphere after travelling an average distance of 150 million kilometre through air and vacuum. The distance it travels through the air is negligibly small compared to that in vacuum. Solar radiations contain visible light, infrared radiation, ultraviolet radiation, etc. They do not require a medium to travel. They travel through vacuum at a speed of 300,000 kilometre per second (3×10^8 m/s). Such radiations are electromagnetic radiations.

The orderly distribution of electromagnetic radiations is known as the electromagnetic spectrum.

Observe figure 3.10. Name the radiations that constitute the electromagnetic spectrum. List them in the ascending order of wavelength.



Electromagnetic spectrum

Fig.3.10

Is white light produced only when all the colours of visible light are combined?

Primary Colours and Secondary Colours

Arrange LEDs emitting red, green, and blue light at an angle of 120° on a circular disc. Pass the light from the LEDs through a PVC pipe and project it onto a screen. Set the position of the PVC pipe such that the red, green, and blue colours overlap.

What do you observe? Based on your observations, complete table 3.2.

Overlapping colours	Resulting colours on overlapping
Red + Green	Yellow
Red + Blue	
Blue + Green	
Red + Green + Blue	

Table 3.2

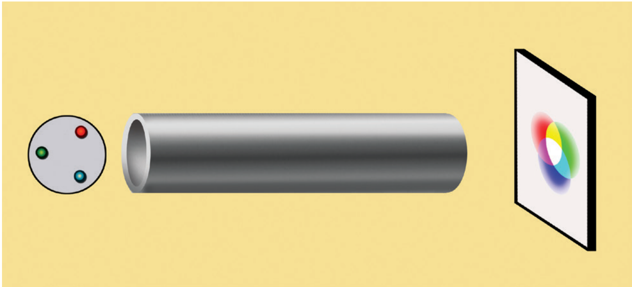


Fig. 3.11

In the region where red, green, and blue colours of the same intensity are combined, we see white light. The region where red and green combine appears as yellow, the part where green and blue combine appears as cyan, and the part where red and blue combine appears as magenta.

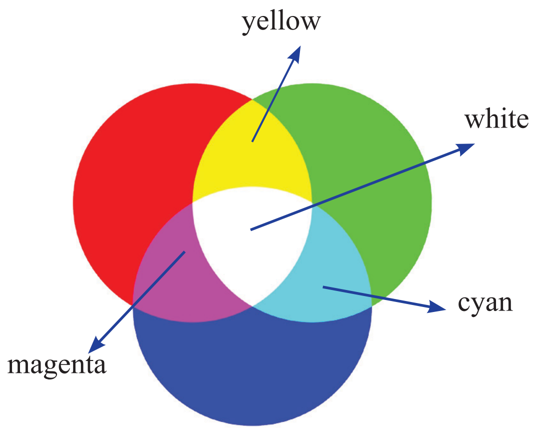


Fig. 3.12

Not only white light, but all other coloured lights can also be created using red, green, and blue lights. Therefore, these colours are called the primary colours of light. The coloured light formed by combining any two primary colours is a secondary colour of light.

Find the secondary colours from figure 3.12 and write them down.

- What are the primary colours in yellow light?
- Which primary colour is not present in yellow light?
- Which colour will be obtained when yellow light is combined with the primary colour that is not present in yellow?

The yellow light from a sodium vapour lamp is not a composite light. Hence, red and green objects appear dark in this light.

- If we add a primary colour that is not a constituent of the secondary colour, won't we get white light?

When a secondary colour is combined with a primary colour, we get white light. Such pairs of colours are called complementary colours. Complete table 3.3 with regard to complementary colours.

Secondary Colour	Component Colours	Complementary Colour
Yellow	Red + Green	Blue
Magenta		
Cyan		

Table 3.3

Colours and Dyes

Red, green and blue (RGB) are primary colours while considering colours of light. But in the case of dyes, cyan, magenta and yellow (CMY) are taken as primary colours. The combination of primary colours of the same intensity and primary dyes are given in the table.

Colours of Light	Colour obtained
Blue+ Green + Red	White
Blue + Green	Cyan
Green + Red	Yellow
Blue + Red	Magenta

Dyes	Dye obtained
Cyan + Yellow + Magenta	Dark
Cyan + Yellow	Green
Cyan + Magenta	Blue
Yellow + Magenta	Red

Primary dyes are used in painting and printing. In printing, black dye is also used.

Take a circular disc. Colour half of it with light yellow colour and the other half with light blue colour using crayons. Rotate this circular disc very fast. What do you observe? Why? Why does the circular disc appear white?

Persistence of Vision

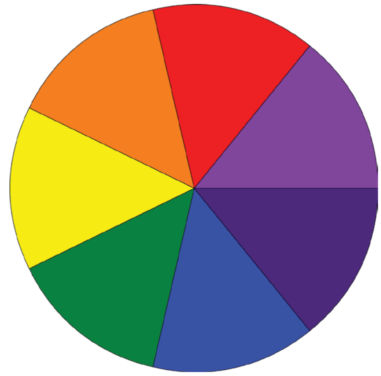
When a burning incense stick is whirled very fast, a ring of fire can be seen. Why?

This is due to the peculiarity of eye called the persistence of vision.

When we quickly remove an object from our field of vision the visual experience of that object persists for about $\frac{1}{16}$ of a second. This phenomenon is the persistence of vision.

Find more examples of persistence of vision.

Newton's Colour Disc



Newton's colour disc
Fig. 3.13

The experiment (Fig. 3.9) clearly shows that white light is obtained when the seven colours of sunlight are combined. Newton's colour disc is a circular disc painted with the colours of sunlight in the same order and proportion. What can be observed when it is rotated very fast? What is the reason?

When Newton's colour disc is rotated very fast, before the visual experience of any one colour vanishes from the eye, the rays from the succeeding colours reach the eyes in quick succession. Due to the phenomenon of persistence of vision, the combined effect of all the colours persists in our eyes and appears almost white.

Explain the following based on the persistence of vision:

- When a torch or a burning stick is rotated very fast, a ring of fire is seen.
-

Make some working models to demonstrate persistence of vision and present them in the class.

Colour of Transparent Objects

Observe figure 3.14.

- How did the children view the flowers?
- What is the colour of the filter in the spectacles they wore?

Pass white light through the filters (through transparent objects) given in figure 3.15 and project it onto a white screen.

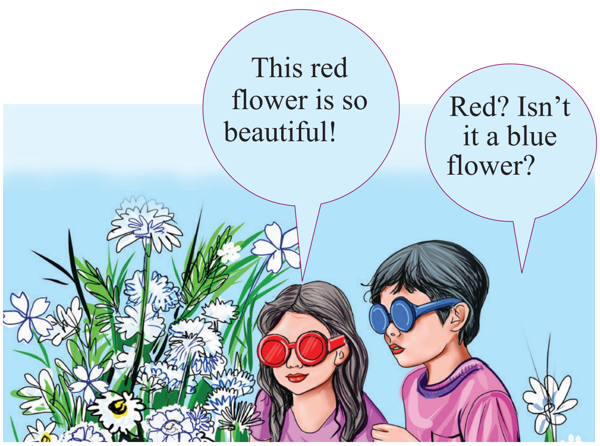


Fig. 3.14

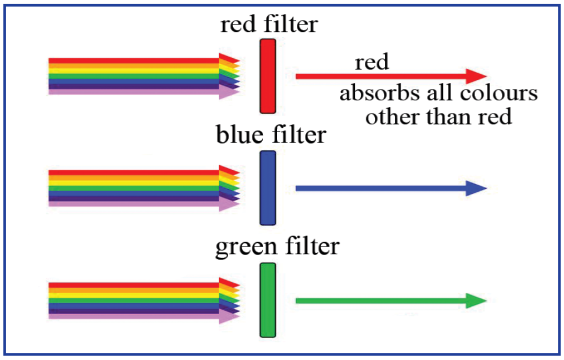


Fig. 3.15

Record the observations of each case in table 3.4.

Light falling on the filter	Colour of the filter	Colour of light passing through the filter
White light	Red	Transmits red colour in the white light
	Green	
	Blue	

Table 3.4

- Now let us pass each of the primary colours and white light through a yellow filter. What do you observe?
- Identify the components of white light transmitted through each filter.
- What happens to the other colours that fall on the filter?

Here, in each case, the filters transmit only the colour of the filter and its component colours from the white light, and block the other colours.

Complete table 3.5 related to secondary colours.

Filter	Light falling on the filter	Transmits / Does not transmit
Magenta	Red	Transmits red
	Green	
	Blue	
	Yellow	Transmits red
	White	Transmits red and blue

Table 3.5

A filter of secondary colour transmits light of its own colour and its component colours.

In a textile shop the colour of clothes are very different from their colour seen in sunlight. What is the reason for this difference?

Colour of opaque objects

We see an object in the colour of the light that is reflected from the object to our eyes.

Then, which colours will be reflected when sunlight (white light) falls on the objects given below? Complete table 3.6.

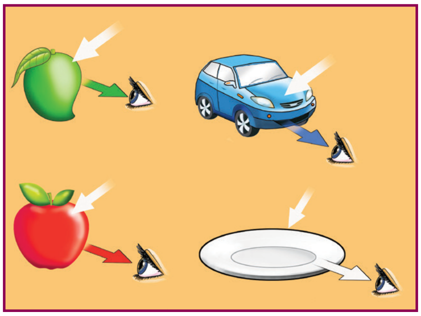


Fig. 3.16

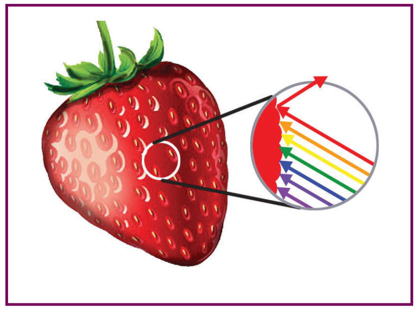


Fig. 3.17

Object	Reflected light
Blue car	Blue
Green mango	
White vessel	
Red apple	

Table 3.6

When sunlight falls on an opaque object, it reflects the colour of the object as well as the colours associated with adjacent wavelengths. It should be remembered that the colour of an object is not of a single wavelength. Similarly, there may be slight differences in colour perception depending on the light-sensitive cells (rods and cones) in the eyes of each individual. What happens to all other colours?

The object absorbs all other colours.

Write down the results obtained by observing the given objects in green, blue, and yellow lights and complete the table.

Objects	Light	Colour of the object seen
Red flower	Red	Red
	Green	Dark
	Yellow	Red
Green leaf	Red	
	Green	
	Yellow	
Yellow flower		Red
		Green
		Yellow

Table 3.7

The beautiful colours of Peacock and Butterfly

The beautiful colours of peacock feathers and butterfly wings are primarily due to their microscopic structure rather than pigments. This is based on the arrangement of nanostructures called photonic crystals in their feathers or wings. The various light phenomena through nanostructures are responsible for the fascinating and varied colours.

What are the inferences obtained on analysing the table?

- What colours do a green leaf reflect? And what about a red flower?
- Can a yellow flower reflect only the yellow colour?

An opaque object of a secondary colour can reflect light of its colour and its component colours.

- In which colour will a surface appear if it reflects all colours of light falling on it? And what about a surface that absorbs all colours?

A surface that reflects all colours will appear white in white light. We know that a surface that absorbs all colours appears dark.

In the introductory picture, the same light falls on all the flowers in the garden. But why does each appear in a different colour? Now can't it be explained? Sunlight is a composite light. It contains different colours. When sunlight falls on objects, each object reflects different colours according to its colour. Accordingly, objects are seen in different colours.

Why does the sky usually appear blue?

Scattering of Light

The schematic diagram shows the scattering of light rays due to their collision with the microscopic particles in the atmosphere (Fig.3.19).

Fig. 3.18

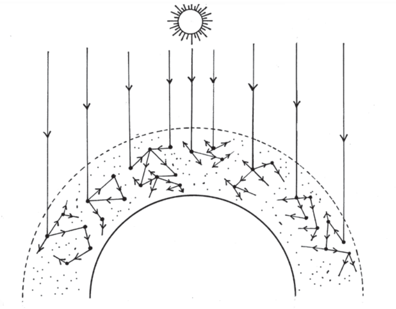


Fig. 3.19

- Which type of scattering does light undergo when it falls on microscopic particles? (regular / irregular)
- Does this type of scattering cause sunlight to spread everywhere? Discuss. The phenomenon of spreading of light in this manner is scattering.

Scattering is the irregular and partial directional deviation of light when it encounters particles in a medium.

Do all the component colours of white light undergo scattering in the same manner? Let's see. Take about three quarters of water in a rectangular glass jar. Allow light rays from a torch to pass through the water in the jar onto the screen as shown in the figure. Dissolve sodium thiosulphate in the water at a concentration of two gram per litre. Add one or two drops of hydrochloric acid to it. Observe the gradual change of light in the solution and on the screen.

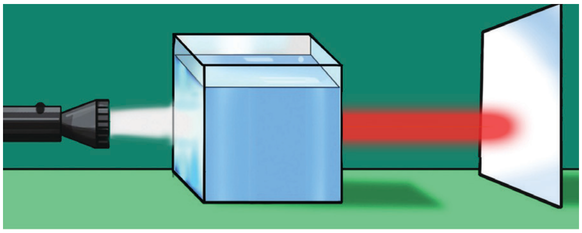


Fig. 3.20

- Which colour spreads first in the solution?
- Write down in order the colour changes seen on the screen.
- Which is the last colour to appear on the screen?

When sodium thiosulphate and hydrochloric acid react, colloidal sulphur is precipitated. The size of the particles gradually increases. Discuss the change in scattering in relation to wavelength as the size of the sulphur particles gradually increases.

Violet, indigo and blue colours in sunlight, which have shorter wavelengths, undergo more scattering when they encounter particles in the atmosphere. The scattering of red, having a relatively longer wavelength, is very low. Hence red can travel a longer distance through the atmosphere.

The extent of scattering and the size of the particles are related to each other. As the size of the particles increases, so does the scattering. If the size of the particles is greater than the wavelength of light, the scattering will be the same for all colours.

Tyndall Effect

Take water mixed with chalk powder in a beaker, as shown in figure 3.21. Pass light from a torch through it.

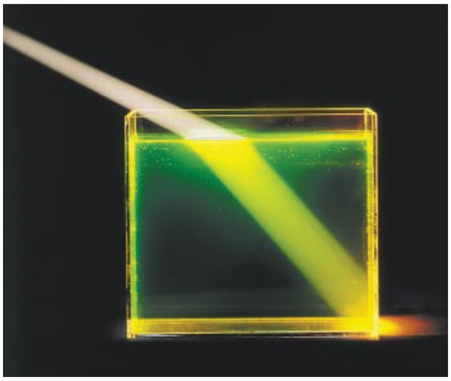


Fig. 3.21

- What do you observe?

Can you see the path of light?

Don't you know that water mixed with chalk powder is an example of a suspension? The path of light can be clearly seen due to the scattering of light when it passes through a suspension.

Similarly, in winter, paths of light through the gaps of the branches of trees can be seen clearly due to scattering.

> When light rays pass through a colloidal liquid or suspension, they get scattered, causing tiny particles to become illuminated, making the path of light visible. This phenomenon is the Tyndall effect.

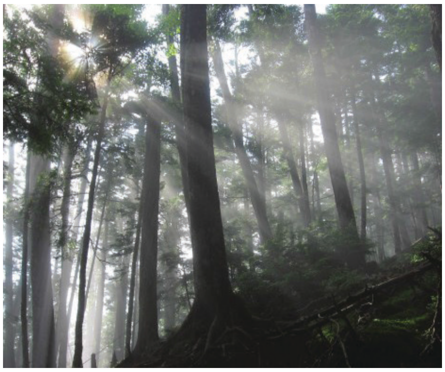


Fig. 3.22

The intensity of scattering depends on the size of the particles in the colloid. As the size of the particles increases, the intensity of scattering increases.

Let's consider some other situations related to scattering.

Blue Colour of the Sky

Why does the sky appear blue?

Observe figure 3.23.

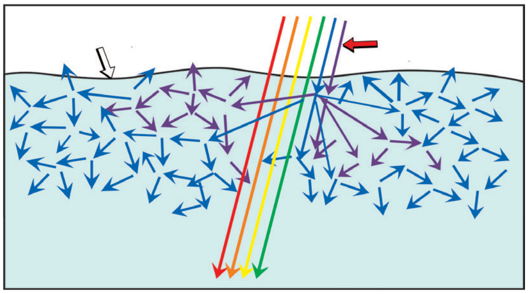


Fig. 3.23

You know that light undergoes scattering when it passes through the atmosphere.

- Which colour undergoes maximum scattering?
- Then, which colour of light spreads in the atmosphere?

When sunlight travels through the atmosphere to reach the Earth, some of its components undergo scattering as it passes through the air. Scattering occurs most for colours with shorter wavelengths such as violet, indigo and blue. This scattered light spreads in the sky. The resultant scattered light that reaches the observer's eye gives the effect of the blue colour. So the sky appears blue.

Colour of Setting and Rising Sun

Why does the sun appear red or yellow or orange during sunrise and sunset? Find out by analysing figure 3.24.

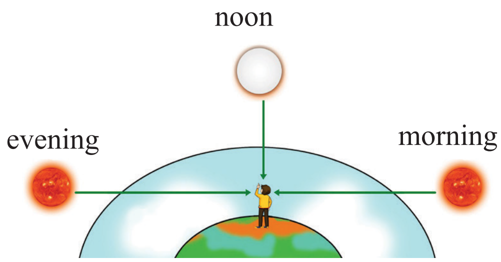


Fig. 3.24

- The distance that the sun's rays travel through the atmosphere to reach the Earth during sunrise and sunset compared to other times is

  (more / less)
- Which colours undergo the least scattering at these times?
- Which colour will be prominent in the light reaching the Earth?

If so, explain why the sun appears red, yellow, or orange during sunrise and sunset.

Eye and Vision

We can see the beautiful sights in nature with the help of our eyes.

How do eyes enable vision?

Take a convex lens of focal length10 cm. Place a burning candle at a distance of 20 cm away from the lens. Adjust the position of the screen to get a clear image of the flame.

Observe and understand the arrangements used here to form the image.

In the same way, an image of an object is formed in our eyes.

Compare the image formation in the experiment with the image formation in the eyes. Write down the similar parts which contribute to the image formation in both cases.

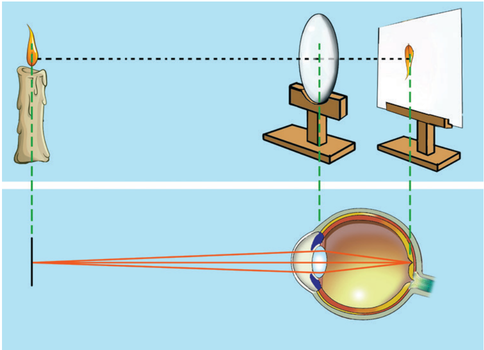


Fig. 3.25

Now try changing the position of the object to a distance 30 cm from the lens. Is a clear image formed on the screen now?

Replace the lens of focal length 10 cm with a lens of focal length 12 cm.

- What do you observe?

Isn't a clear image of the object formed on the screen?

- What could be the reason for getting a clear image now?

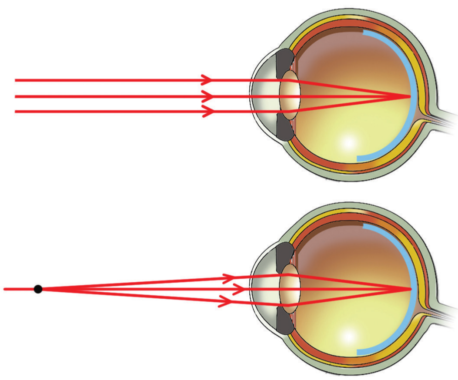


Fig. 3.26

Note that a clear image was obtained at the same position when a lens with a suitable focal length was used. When the object is placed at different positions, to get a clear image at the same position, the focal length of the lens must be adjusted accordingly.

How are images of objects at different distances formed on the retina?

This is made possible by changing the curvature of the lens in the eye with the help of the ciliary muscles by changing the focal length. When the ciliary muscles contract, the curvature of the lens increases and the focal length decreases.

- What change will occur in the curvature of the lens while looking at distant objects?
- What about the focal length when the curvature decreases?

The ability of the eye to change the curvature of the lens and adjust the focal length so that the image of the object always falls on the retina, regardless of the position of the object, is the power of accommodation of the eye.

You have understood that due to the power of accommodation of the eye, a clear image of objects at different distances is formed on the retina itself.

Will clear images be formed on the retina when objects are kept very close to the eye?

Let's do an activity.

Try reading a book by holding it close to your nose.

- Can you see the letters clearly?
- What if you move the book away?
- At what distance from the eye can you see the letters clearly?

Measure this distance. This distance is the least distance of distinct vision. The nearest point at which an object can be seen clearly is the near point. For healthy eyes, the minimum distance for clear vision is 25 cm.

- What is the maximum distance at which an object can be seen clearly?

The farthest point at which an object can be seen clearly is the far point. This distance is considered to be infinity.

- Will the near point and far point be alike for everyone?

Short sightedness / Myopia

Some people can see nearby objects clearly but cannot see distant objects. This defect of the eye is short sightedness. The schematic diagram shows the vision of a person with this defect.

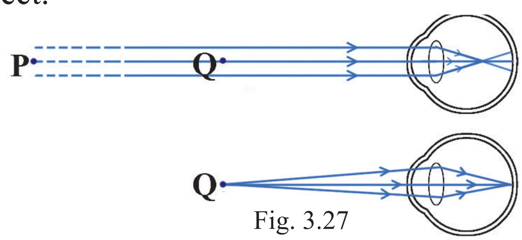


Fig. 3.27

- When an object is placed at a distant point P as shown in the figure, where will the image be formed?
- Can the object be seen clearly?
- What if the object is at Q?
- Why can't such people see distant objects clearly?

For people with this defect, the far point will not be at infinity. It will be at a certain distance from the eye.

- What could be the reason for short sightedness? Can you explain the reason based on the size of the eyeball and the power of the lens in the eye?
- The size of the eyeball is
  (larger / smaller)
- The power of the lens is
  (more / less)

Write down your conclusions in the science diary.

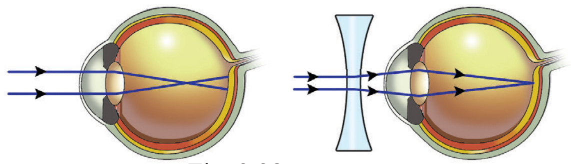


Fig. 3.28

- Observe figure 3.28 to find out how shortsightedness is rectified.

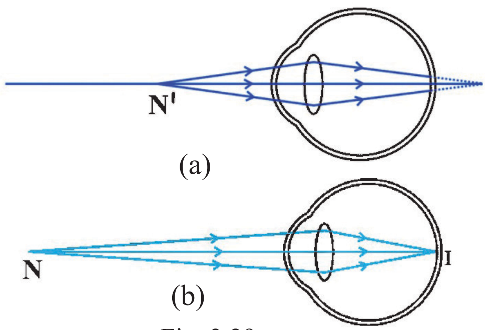
Short sightedness can be rectified using a concave lens with suitable power.

Long sightedness / Hypermetropia

Some people can see distant objects clearly but cannot see nearby objects clearly. This defect of the eye is long-sightedness.

The figures showing the image formation in the eye of a person with long sightedness are given [Fig.3.29 (a), (b)].

Didn't you observe that the distance to the near point of a person with long sightedness is different? By observing the image, you may have understood that a clear image is not formed on the retina of a person with long sightedness.



(a)

(b)

Fig. 3.29

The near point of a person with long sightedness will be more than 25 cm.

- Find the reason for this defect based on the size of the eyeball and the power of the lens in the eye.
- The size of the eyeball is (larger / smaller)
- The power of the lens is (more / less)
- How can long sightedness be rectified? Find out from figure 3.30.

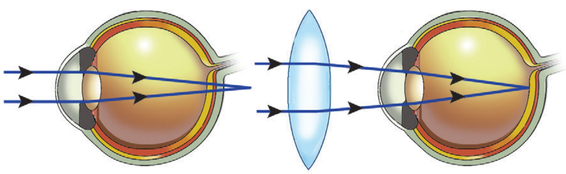


Fig. 3.30

Long sightedness can be rectified using a convex lens with suitable power.

Presbyopia

What is the distance to the near point for a healthy eye?

For older people, the distance to the near point may be more than 25 cm. This is because the efficiency of the ciliary muscles decreases. Such people have less power of accommodation. This is presbyopia.

Light Pollution

Although light is essential for the survival of life on Earth, artificial light harms the natural habitat of the biosphere. Light pollution refers to the creation of artificial light in excessive amounts and intensity. Artificial light adversely affects the reproduction and predation of many nocturnal animals.

Excess of artificial light adversely affects the natural activities, mental and physical health of humans. What are the other consequences of light pollution? Prepare a note on this to present in class.

- Causes difficulty during night drive.
- Makes astronomical observations difficult by obstructing the night sky.
- The light from multi-storeyed flats misleads migratory birds.
-

Photoperiodism

Certain categories of plants bloom, bear fruit and shed leaves at different times of the year. A type of protein called phytochrome found in leaves controls this biological clock. The phytochrome controls this mechanism by identifying the amount of sunlight received in each season. This phenomenon is photoperiodism. The fact that the leaves on the branches of a tree growing near a street lamp do not fall is an example of the effect of light pollution on the photoperiodism of plants.

Let's Assess

1. Find the most appropriate answer.

Name the optical phenomena taking place when light rays pass through water droplets to form a rainbow.

a) internal reflection b) refraction

c) refraction and internal reflection d) none of these

2. Which of the following pairs of colours can produce white light?

a) magenta, blue b) yellow, green c) red, green d) magenta, green

3. When a ray of white light enters obliquely and passes through a prism

i) does not undergo refraction ii) undergoes dispersion

iii) undergoes dispersion and deviation iv) not subjected to any of these

Choose the correct option.

a) ii & iii b) iv c) i & iv d) none of these

4. Fill in the blanks appropriately:

   a) Cyan colour + ... $\rightarrow$ white light b) Blue colour + ... $\rightarrow$ white light

   c) Magenta colour + green colour $\rightarrow$ ....

   d) Magenta colour + cyan colour + yellow colour $\rightarrow$ ....

5. Give scientific explanations based on scattering for the following:

   a) Red light is used for emergency lamps.

   b) The sky of the moon appears dark even during the day.

   c) The deep sea appears blue.

6. Complete the path of a light ray falling on the glass prism (Fig. 3.31).

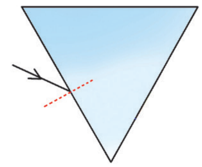


Fig. 3.31

7. What are the radiations that are seen on either side of visible light in the electromagnetic spectrum? Write one use of the radiation with a shorter wavelength than visible light.

8. The near point of a person with hypermetropia is 40 cm.

   a) Can this person read the letters in a book held 25 cm away?

   b) Can this person see an object at infinity?

   c) How can this defect of the eye be rectified?

9. Water is colourless, but it appears white in waterfalls. Why?

10. Based on the colour of illumination in the room, how can the coloured objects given in the table be seen? Complete the table.

Colour of the object	Light in the room					
	Green	Blue	Red	Magenta	Cyan	Yellow
Magenta						
Green						

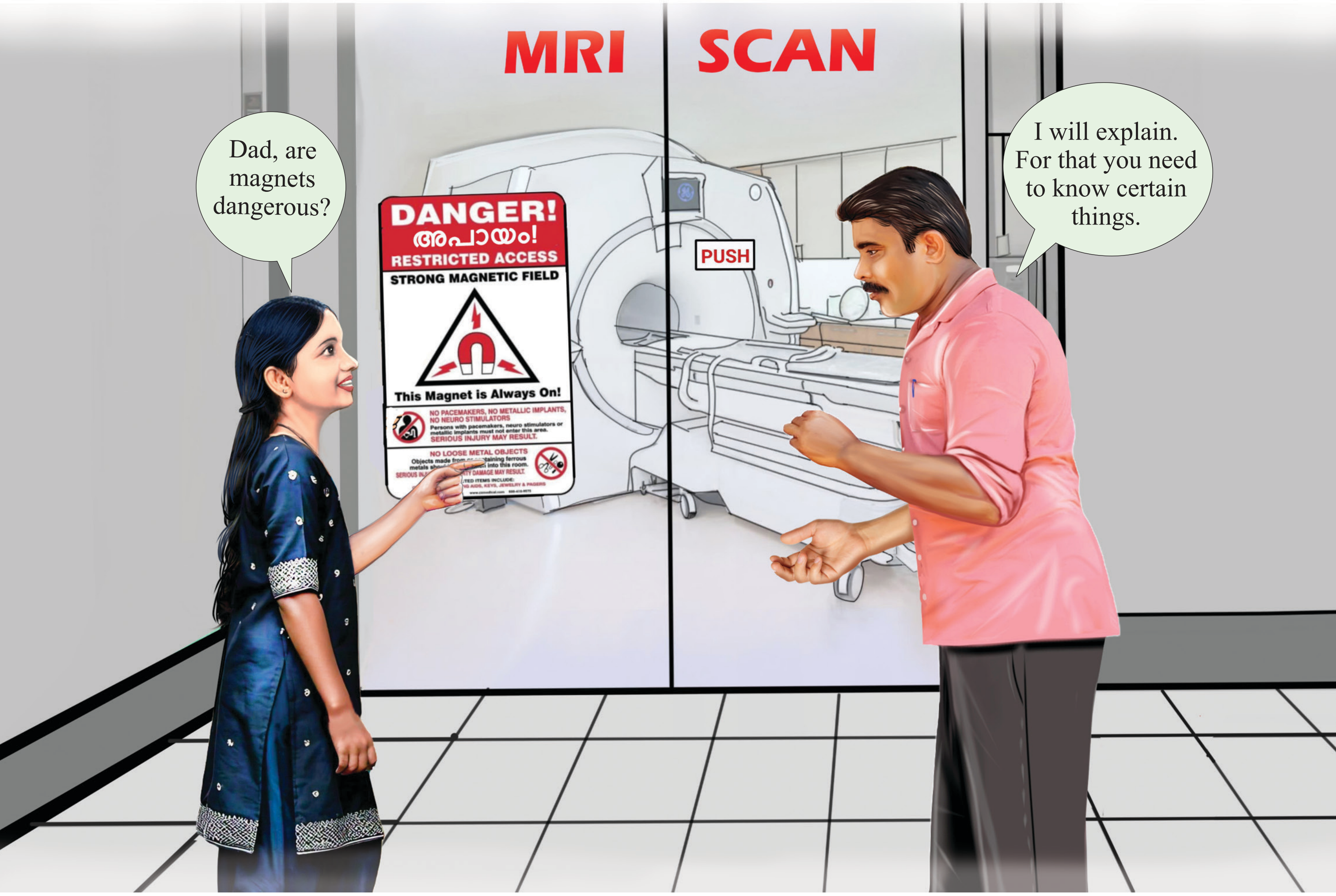
Table 3.8

Extended activities

1. Prepare a note on the differences between colours of light and dyes.

2. Construct Newton's colour disc and operate.

4 Magnetic Effect of Electric Current



Have you also had similar doubts?

Let's do some activities.

Take a pivoted magnetic needle. Bring a piece of wood near to it.

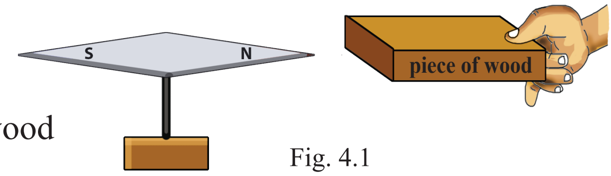


Fig. 4.1

- What do you observe?
  The magnetic needle (deflects / doesn’t deflect)
- Bring a bar magnet near the magnetic needle instead of the wooden piece. What do you observe?

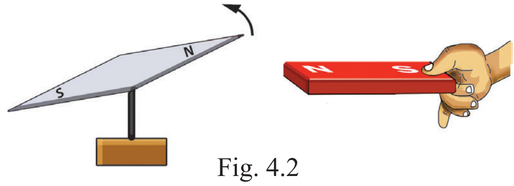


Fig. 4.2

PhET→ Magnets and Compass

- What is the reason?

Isn't the magnetic needle deflected because of the attraction and repulsion between the two magnetic poles?

You have now understood that if another magnetic field is created near the magnetic needle, the magnetic needle will deflect.

Don't you know that there is a magnetic field around a magnet?

There are many magnetic field lines (flux lines) within a magnetic field. These imaginary lines are used only to visualise the magnetic field.

- Using a magnetic compass, draw the magnetic flux lines around a bar magnet in your science diary.

Compare your drawing with the given figure.

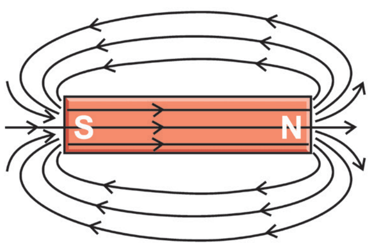


Fig. 4.3

- What is the direction of the magnetic flux lines surrounding a magnet?
- What is its direction inside the magnet?

Can we create a magnetic field without using permanent magnets?

Current Carrying Conductor and Magnetic Field

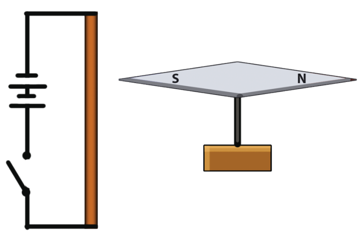


Fig. 4.4

Make a circuit as shown in figure 4.4 using a conducting rod, connecting wires, a 9 V cell and a bell switch. Bring it near a pivoted magnetic needle.

- When the bell switch is off, what is the direction of the magnetic needle?
- Now turn on the bell switch. What do you observe?
- Why did the magnetic needle deflect now?

Now we can understand that a magnetic field is formed around a current carrying conductor.

A magnetic field is formed around a current carrying conductor. This magnetic field can exert a force on a magnetic needle. This is the magnetic effect of electricity.

Does the direction of deflection of the magnetic needle depend on the direction of the current?

Arrange a circuit as shown in figure 4.5 in such a way that the conducting rod AB is above the pivoted magnetic needle, parallel and close to it.

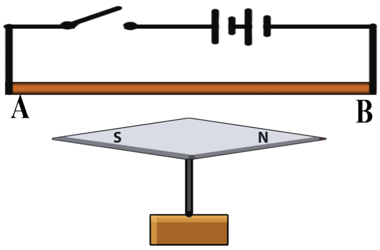


Fig. 4.5

- What do you observe when the bell switch is turned on?
- In which direction does the north pole of the magnetic needle deflect when viewed from above?

  (clockwise direction / anticlockwise direction)

Clockwise direction **Anticlockwise direction**

The clockwise direction is the direction in which the hands of a clock move. The anticlockwise direction is the direction opposite to it.

Haven't we learned that a magnetic field can exert a force on a magnetic needle? In the previous experiment, the force necessary to move the magnetic needle is created by the magnetic fields. Isn't this magnetic field due to the current passing through the conductor?

Reverse the direction of the current. Now isn't the magnetic needle deflecting in the opposite direction?

- What could be the reason? Write down your inference.

Isn't this because the direction of the magnetic field around the conductor has reversed?

- In figure 4.5, which direction does the north pole of the magnetic needle deflect, when the current is from A to B?

  (clockwise direction / anticlockwise direction)
- What is the direction, if the current is from B to A?

  (clockwise direction / anticlockwise direction)

Repeat the experiment by placing the conductor below the magnetic needle.

- When the current is from A to B, in which direction does the north pole of the magnetic needle deflect?

  (clockwise direction / anticlockwise direction)

Hans Christian Oersted

Lifetime : 1777-1851

Birthplace : Denmark

Hans Christian Oersted was a Danish scientist. In 1820 he conducted an experiment that demonstrated the relationship between electricity and magnetism. These experiments laid the foundation for advancements in the field of electricity. The CGS unit of intensity of the magnetic field is named oersted in honour of him.

- What is the direction, if the current is from B to A?

  (clockwise direction / anticlockwise direction)

Through this experiment, the scientist Hans Christian Oersted discovered that a magnetic field is formed around a current carrying conductor.

Can we find out the direction of the magnetic field around a current carrying conductor?

Let's do an experiment to understand the relationship between the direction of the current and the deflection of the magnetic needle.

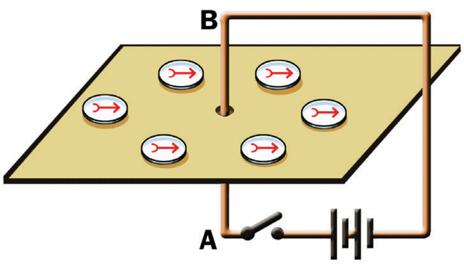


Fig. 4.6

Pass a copper wire through a cardboard and arrange it perpendicular to the surface of the cardboard as shown in the figure.

Connect the copper wire in series with a 9V battery and a bell switch. Arrange small magnetic compasses in a circular shape around the copper wire on the cardboard as shown in the figure. Turn on the bell switch. Observe the direction of deflection of the north pole of the magnetic needle.

- When the current is from A to B, in which direction does the north pole of each magnetic needle deflect?

  (clockwise / anticlockwise)

Observing the magnetic compasses mark the north poles of the magnetic needles on the cardboard.

After removing the magnetic compasses from the cardboard, draw the magnetic field lines and mark their direction.

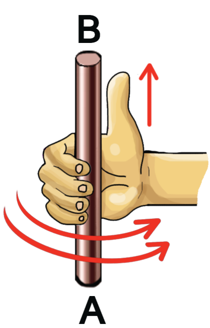


Fig. 4.7

- What is the direction of the magnetic field now?

  (clockwise / anticlockwise)

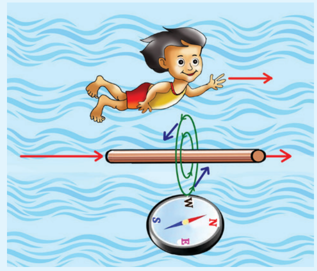
Now, imagine holding the current carrying conductor AB with your right hand so that your thumb points in the direction of the current.

- Compare the direction indicated by the tips of your fingers curling around the conductor with the direction of the magnetic field. Aren't they the same? Write down your findings in the science diary.

This method of finding the direction of the magnetic field around a current carrying conductor is known as the right hand thumb rule.

Right Hand Thumb Rule

Imagine holding a conductor with your right hand in such a way that the thumb points in the direction of the electric current, the fingers curled around the conductor will indicate the direction of the magnetic field.



Ampere's Swimming Rule

Ampere's swimming rule can also be used to find the direction of the magnetic field around a current carrying conductor. Imagine a person swimming in the direction of the electric current, looking at the magnetic needle, as shown in the figure. The north pole of the magnetic needle will deflect towards the left side of the person.

Let's do another activity (Fig. 4.8).

Make two holes in a cardboard. Pass a copper wire through these holes and make a loop. Arrange half of the loop above the cardboard and half below as shown in the figure. Place magnetic compasses near the holes through which the copper wire passes. Connect the loop of wire to a battery and a bell switch.

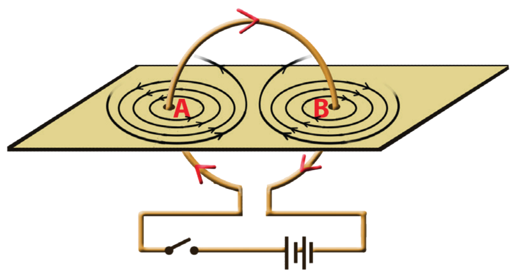


Fig. 4.8

- Turn on the bell switch. What do you observe?

Find the direction of the magnetic field at points A and B by observing the magnetic compasses.

- In which direction does the current flow in the part of the coil that faces you?
  (clockwise direction / anticlockwise direction)
- In this case, what is the direction of the flux lines?
  (into the coil / out of the coil)
- What happens to the magnetic field if the bell switch is turned off?

If the current in the coil is clockwise, the direction of the flux lines will be inward into the coil. If the current is anticlockwise, the direction of the flux lines will be outward.

Haven't you noticed that there was no magnetic force when there was no current in the circuit? From this, we can understand that the magnetic force obtained from the coil is temporary (only when there is current).

Is there a way to increase the magnetic strength associated with a coil of wire?

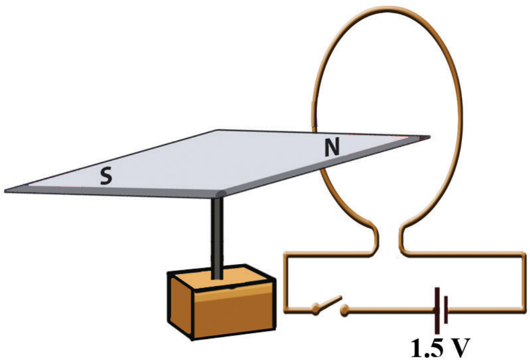


Fig. 4.9

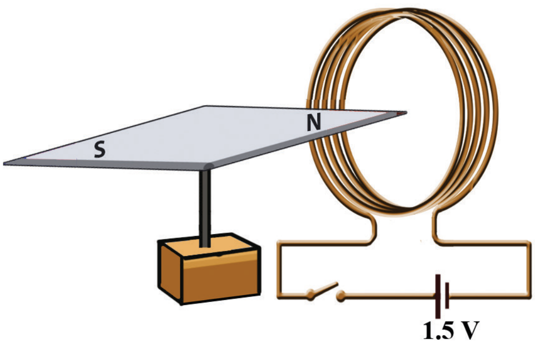


Fig. 4.10

Connect a coil of wire to a battery and a bell switch. Hold the coil near one end of a pivoted magnetic needle.

- Turn on the bell switch. What do you observe?

Now increase the number of turns of the coil and hold it near the magnetic needle. Pass the same current through it.

- What change do you observe in the deflection of the magnetic needle?
- What change has occurred in the magnetic strength?

Then, replace the 1.5 V cell with a 3 V battery and pass the current.

- Now, has the deflection of the magnetic needle increased or decreased?
- If so, write down the factors that affect the strength or intensity of the magnetic field around a coil of wire.
  - ➢ Number of turns of the conductor
  - ➢

When the number of turns of the conductor increased, both the magnetic strength and the magnetic flux increased, but the flux produced by a single turn of the conductor did not increase.

How can we utilize the magnetic effect of electric current using coils of wire?

Solenoid

Take a PVC pipe of length 10 cm and diameter 4 cm (1.5 inch). Wind 2 m insulated copper wire of gauge 26 around it. Remove the copper coil from the PVC pipe without deforming the coil. What is the shape of the coil now? Doesn't it look like a spring [Fig.4.11(a)]? An insulated conductor wound in a spiral shape is a solenoid. The centres of all the turns lie on the same straight line.

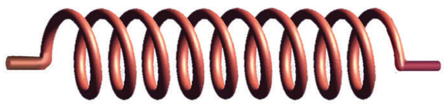


Fig. 4.11 (a)

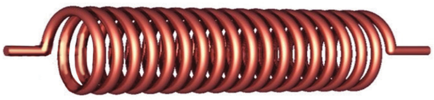


Fig. 4.11 (b)

Similarly, prepare another solenoid of the same length as the first one by winding 4 m of insulated copper wire on the same PVC pipe [Fig. 4.11 (b)].

Arrange magnetic compasses around the first solenoid. Connect the solenoid to a 9 V battery and a bell switch (Fig. 4.12).

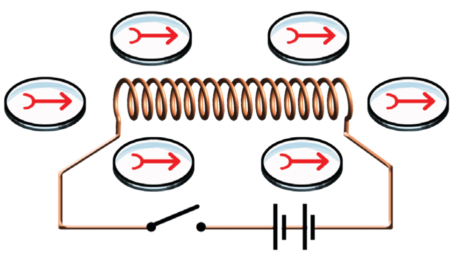


Fig. 4.12

What do you observe when you turn on the bell switch?

Repeat the experiment using the second solenoid.

- Now, what do you observe? (the deflection increases / decreases)
- What is the reason?
- Increase the current through the solenoid. What about the deflection of the magnetic compasses?

  (increased / decreased)
- Place a piece of soft iron as the core of the solenoid. Turn on the bell switch (Fig. 4.13). What do you observe?
- Place a soft iron core with a larger area of cross section. Turn on the bell switch. What do you observe? (Fig. 4.14)

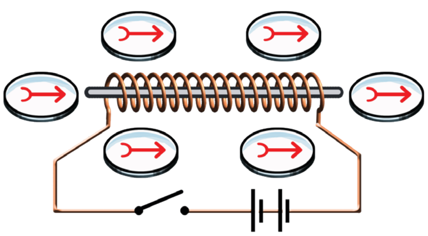


Fig. 4.13

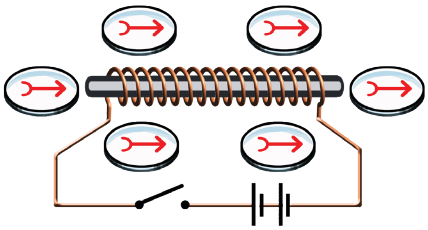


Fig. 4.14

Observe the magnetic compasses at the ends of the solenoid and determine the polarity at each end.

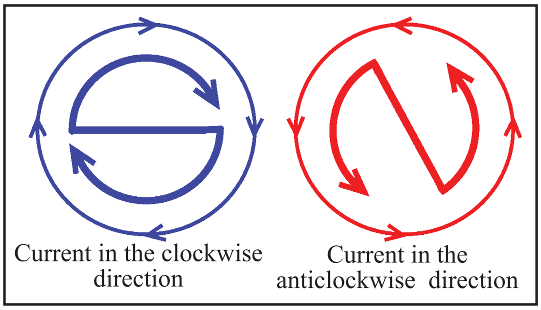


Fig. 4.15

- If the current flows in clockwise direction at one end of the solenoid, what will be the polarity at that end?

  (south pole / north pole)
- What about the end in which the current is in anticlockwise direction?

Imagine holding a solenoid with your right hand. When your fingers curl around in the direction of the current, isn't your thumb pointing towards the north pole of that solenoid?

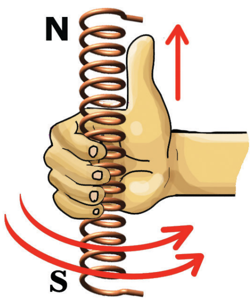


Fig. 4.16

If you hold a current carrying solenoid with your right hand in such a way that your four fingers curl the coils in the direction of the current, the thumb points towards the north pole of the solenoid.

The solenoid utilizes magnetic effect of electricity for practical purposes.

PhET→ Magnets and Electromagnets

Based on the activities conducted so far, write down the factors that influence the magnetic strength of a current carrying solenoid.

- The number of turns of the conductor per unit length.
-

Electromagnets are devices that create magnetic field using electricity.

? **Explain how a strong electromagnet can be made.**

Are there similarities between the magnetic field around a bar magnet and that around a current carrying solenoid?

Sprinkle iron filings on an acrylic sheet placed over a bar magnet and observe.

Compare it with figure 4.17 (a) and record your inferences in the science diary.

Now sprinkle iron filings on an acrylic sheet placed on top of a current carrying solenoid [Fig. 4.17 (b)].

- What do you observe?

- Haven't you understood that the magnetic field lines around a bar magnet and a solenoid are alike?

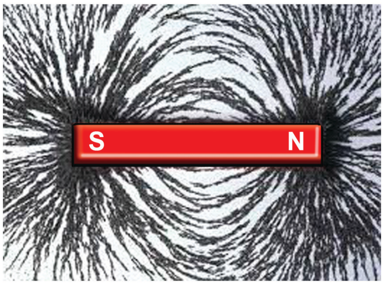


Fig. 4.17 (a)

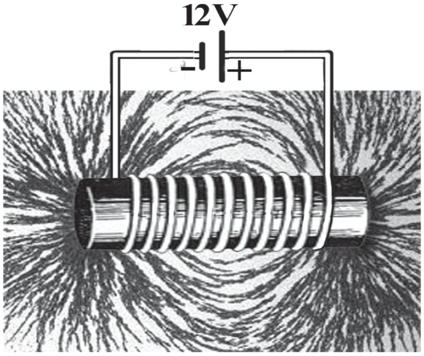


Fig. 4.17 (b)

Complete table 4.1 by comparing the stability of magnetic field, polarity, and the possibility of change in magnetic strength etc., of a bar magnet and a current carrying solenoid.

Bar magnet	Current carrying solenoid
Magnetism is permanent	
	Magnetic strength can be varied.
Polarity cannot be changed	

Table 4.1

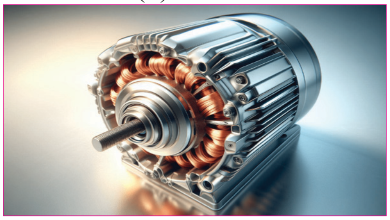
- If the strength of the electromagnets is significantly increased, won't they attract surrounding magnetic materials strongly?

Observe situations in (Fig. 4.18) where strong magnetic fields are used.

Cranes using electromagnets
(a)

Maglev train
(b)

MRI scanner
(c)



Electric motor
(d)

Fig. 4.18

Very strong electromagnetic fields are used in MRI (Magnetic Resonance Imaging) scanning. We know that patients are asked to remove all ornaments (made of metal) before undergoing an MRI scan. Since the magnetic field of the MRI scanner is very strong, magnetic materials are strongly attracted and may cause accidents. The presence of other metals reduces the accuracy of the scanning report. Now haven't you understood the indication of the image seen at the beginning of this unit? If there is a magnetic shielding made of iron sheets (as in an electric motor), the magnetic flux neither flows out nor causes any accidents.

The figures of current carrying conducting loops are given below. Which figures give the correct representation of the magnetic polarity of the end you are facing?

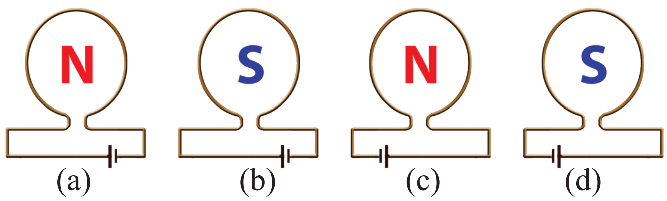


Fig. 4.19

Observe figure 4.20.

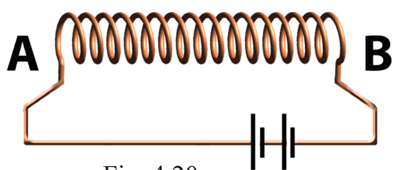


Fig. 4.20

(a) What is the magnetic polarity of end A?

(b) What is the magnetic polarity of end B?

Electric Motor

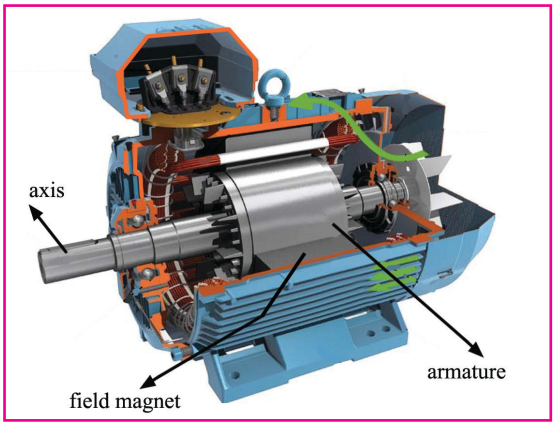


Fig. 4.21

Observe figure 4.21. This is a picture of an electric motor. Don't you see many coils? You know that a magnetic field is created when electricity flows through the coils of wire.

How does the motor work when the switch is turned on?

Let's see how forces are experienced by a current carrying conductor in a magnetic field.

Place a reasonably sized ring magnet on a table with the north pole facing upwards. Place a thin acrylic sheet on top of it. Take two copper wire pieces of length 20 cm each (gauge 16) with its insulation removed. Place them parallel to each other on the sheet above the magnet. Place another piece of copper wire (AB) across on top of them as shown in the figure. Connect the positive terminal of a 12V battery through a bell switch to one of the parallel copper wires. Connect the end of the second copper wire to the negative terminal of the battery.

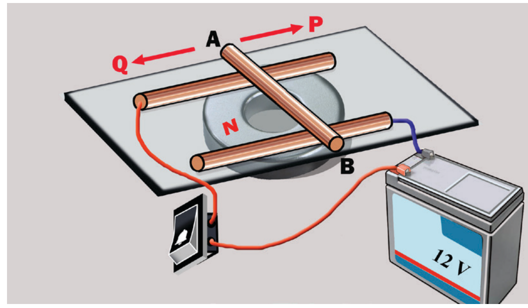


Fig. 4.22

- What do you observe when the switch is turned on?
- Note in which direction the copper wire AB moved.
  (towards Q / towards P)
- Repeat the experiment by reversing the polarity of the battery. In which direction does the copper wire move?
  (towards Q / towards P)
- Repeat the experiment by placing the south pole of the magnet facing upwards. Repeat the experiment by reversing the polarity of the battery. What do you observe?
- What do you observe if the polarity of the magnet and the direction of the current are reversed together?
- What could be the reason for the conductor AB moving in the same direction as before? Write it down in your science diary.

If the direction of the current or the magnetic field is reversed, the direction of motion of the conductor will be reversed.

If the direction of the current and the magnetic field are reversed together, the conductor will move in the same direction as before.

What are the factors that influence the direction of the force experienced by the conductor?

- ➢ Direction of electric current
- ➢

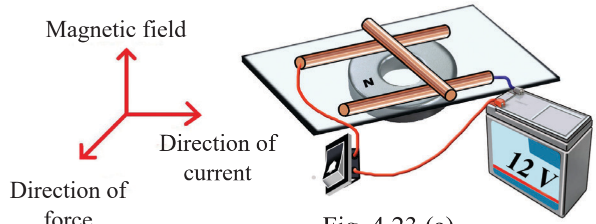


Fig. 4.23 (a)

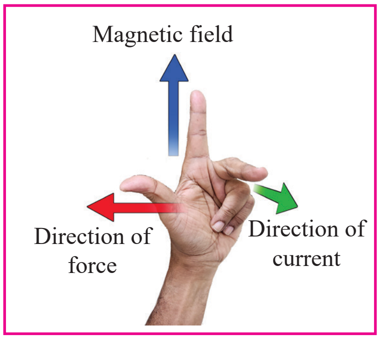


Fig. 4.23 (b)

- In this experiment, in which way are the directions of the electric current and the magnetic field arranged?

  (perpendicular to each other / parallel to each other)

Point the first finger of your left hand in the direction of the magnetic field and the second finger in the direction of the electric current through the conductor.

- Now, isn't the force experienced by the conductor in the direction indicated by the thumb?

Didn't you understand that the direction of the magnetic field, the direction of the electric current, and the direction of motion of the conductor are mutually perpendicular?

The direction of the force experienced by a current carrying conductor placed in a magnetic field, the direction of the magnetic field and the direction of the electric current are mutually perpendicular. This relationship was discovered by John Ambrose Fleming. Fleming's left hand rule is useful to find the direction of motion of a conductor in devices that utilise the magnetic effect of electricity.

Fleming’s Left Hand Rule

Hold the thumb, first finger, and second finger of your left hand perpendicular to each other. If the **F**irst finger points in the direction of the magnetic field and the se**C**ond finger in the direction of the electric current, then the thu**M**b will indicate the direction of the force experienced by the conductor.

While using Fleming's left hand rule to find the direction of motion of a conductor, it will be easier to first confirm the direction of the magnetic field with the first finger.

How does an electric motor work?

Let's do some activities to understand the parts and working of an electric motor. For this, we need cardboard, insulated copper wire, a 9 V battery, a ring magnet, two safety pins, and a conducting wire. Wrap the insulated copper wire around a PVC pipe to make a coil. Make sure that both ends of the coil extend slightly outwards. Remove the insulation at both ends. Arrange the coil, ring magnet and battery as shown in figure 4.24. Make sure that the plane of the coil is parallel to the surface of the cardboard.

- What do you observe when the switch is turned on?
- Why does the coil rotate very fast?

Discuss on the basis of Fleming's left hand rule and write your inference in the science diary.

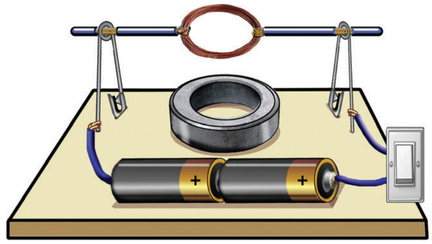


Fig. 4.24

Motor Principle

A current carrying conductor which is free to move, placed in a magnetic field, exhibits a tendency to deflect. This is motor principle.

Motors in electrical appliances like fans and mixies work on this principle.

Observe the schematic diagram of an electric motor (Fig. 4.25).

- Which are the main parts of an electric motor?

N, S → Magnetic poles   PQ → Axis of rotation R_1, R_2 → Split rings

ABCD → Armature B_1, B_2 → Graphite brushes

The armature is made by winding insulated copper wire over a soft iron core of suitable shape. It is firmly attached to the axis PQ. The armature can rotate freely about this axis.

From figure 4.25, you can understand the direction of the current through the armature. Is the direction of the current on sides AB and CD the same, relative to the direction of the magnetic field? You have understood that the direction of the magnetic field is from the north pole to the south pole. Is the force experienced on the side AB and that on the side CD in the same direction? Find out based on Fleming's left hand rule and write it down.

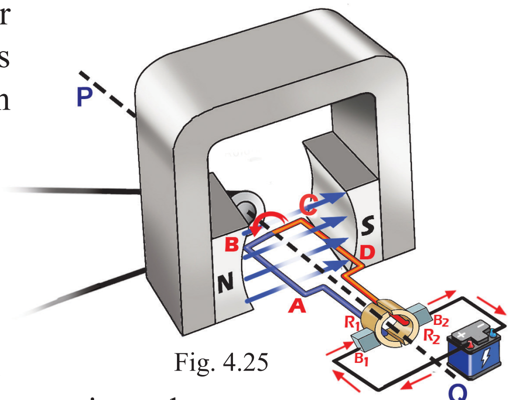


Fig. 4.25

- Direction of the force experienced on side AB (upward / downward)

BLDC Motor (BrushLess Direct Current Motor)

Unlike ordinary DC motors BLDC motors operate without brushes and split rings. Instead of the brushes and rings rubbing against the rotating armature, an electronic switch is used to change the direction of the current as required. Induction motors are used in ordinary fans. Fans using BLDC motors reduce electricity consumption up to 60%. Hence BLDC fans are known as energy saving fans.

- Direction of the force experienced on the side CD is

  (upward / downward)
- What is the effect produced on the armature by the forces experienced on sides AB and CD?

Thus, an electric motor is a device that converts electric energy into mechanical energy based on the motor principle. Isn't the force experienced in opposite directions on the sides AB and CD?

Even though the direction of the magnetic field does not change, the force is experienced on sides AB and CD in opposite directions. Isn’t this because the direction of the current is opposite in AB and CD?

Let’s see how this is made possible after half rotation (180°).

This is made possible by the special arrangement of brushes and split rings.

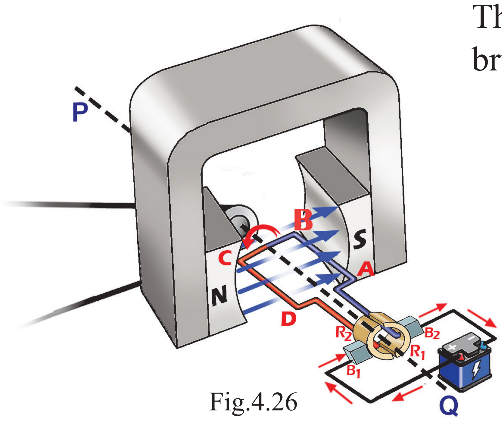


Fig.4.26

- Just before the armature starts rotating (Fig. 4.25), aren't the contacts between the brushes and the split rings B_1R_1 and B_2R_2?
- When the armature completes half rotation (Fig. 4.26), how are the contacts between the brushes and the rings?

  B_1R_2, ...
- When the armature completes one rotation, how are the contacts between the brushes and the rings (Fig. 4.27)?
- At the beginning of rotation (Fig. 4.25), what is the direction of the current through the side AB near the north pole?

  A→B / B →A
- What about side CD near the south pole?

When half rotation is completed (Fig. 4.26), isn't the side CD that comes in front of the north pole?

- What is the direction of the current?

  C→D / D →C

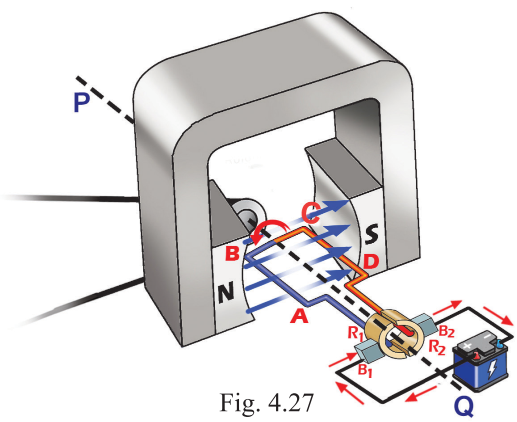


Fig. 4.27

- What is the direction of the current through the side AB that comes in front of the south pole?
- When sides AB and CD reach in front of the north pole, the direction of the current is always

  inwards / outwards
- And when sides AB and CD reach in front of the south pole, what will be its direction?

Thus, the direction of the current is the same in the parts of the armature that reach in front of the magnetic poles. Hence the armature rotates continuously in the same direction.

The split ring commutator is the mechanism used to change the direction of the current through AB and CD after each half rotation.

Are there any other devices that operate based on the motor principle?

Moving Coil Loudspeaker

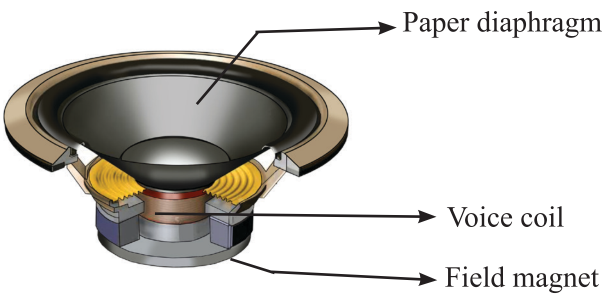


Fig. 4.28 (a)

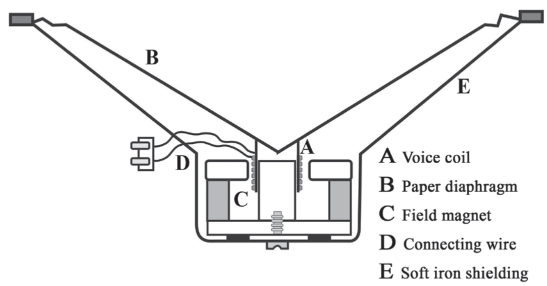


Fig. 4.28 (b)

- What are the main parts of this device?
- Where is the voice coil situated?
- From where do the audio signals (electric signals) reach the voice coil?
- To which part is the diaphragm connected?
- What happens when audio signals pass through the voice coil?
- What happens to the diaphragm?
- What is the energy conversion taking place in this device?

The electric signals (audio signals) received from a microphone are amplified using an amplifier. These audio signals are then passed through a voice coil, which is placed in a magnetic field. The coil experiences a force and vibrates because the coil carrying the electric current is placed in a magnetic field. This vibration causes the diaphragm to vibrate, thus reproducing the sound.

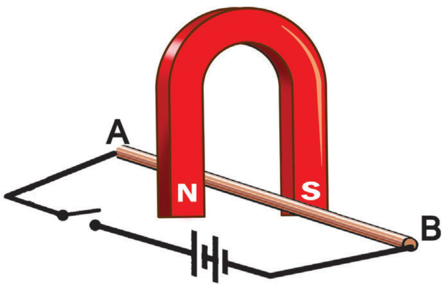


Fig. 4.29

In figure 4.29, AB is a conducting rod that is free to move.

(a) When the bell switch is turned on, in which direction will the metal rod AB move?

b) What should be done to keep the direction of motion of the rod unchanged while changing the direction of the current?

What is the energy conversion that takes place in a moving coil loudspeaker?

Name two devices that work on the principle of a motor.

Let's Assess

1. A conducting wire AB is bent into a loop as shown in the figure. A battery is connected to the ends of the conductor.
   a) When the switch is turned on, find the direction of the magnetic field around the conductor at points A and B.
   b) State the law used for this.
   c) Explain how to find the direction of the magnetic field in a conducting loop.

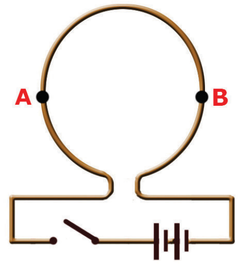


Fig. 4.30

2. The direction of the magnetic field around a current carrying conductor AB is marked. Find the direction of the electric current through the conductor and state the law that supports this.

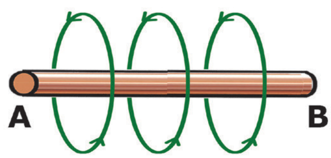


Fig. 4.31

3. Choose the correct statement regarding the magnetic polarity of a current carrying solenoid and write it down

   a) If the current in one end of the solenoid is clockwise, then that end is north pole.

   b) If the current in one end of the solenoid is clockwise, then that end is south pole.

   c) If the current in one end of the solenoid is anticlockwise, then that end is south pole.

   d) None of the above.

4. Observe the diagram.

   a) Identify the device shown in the diagram.

   b) To rotate the armature in a clockwise direction, which terminal of the battery should be connected to the point X?

   c) What is the necessity of using a split ring commutator in this device?

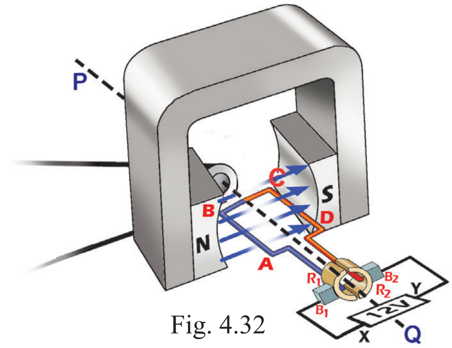


Fig. 4.32

5. What is the function of the diaphragm in a moving coil loudspeaker?

   a) To amplify sound signals.

   b) To convert mechanical energy into sound waves.

   c) To separate high frequency sound signals.

   d) To increase the strength of the magnetic field.

6. A conductor is held above and parallel to a magnetic needle.

   a) What causes the magnetic needle to deflect when the switch is turned on?

   b) Suggest two ways to reverse the direction of this deflection.

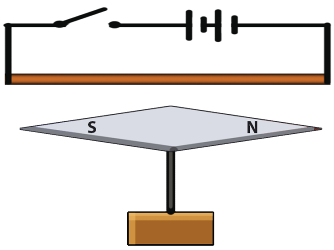
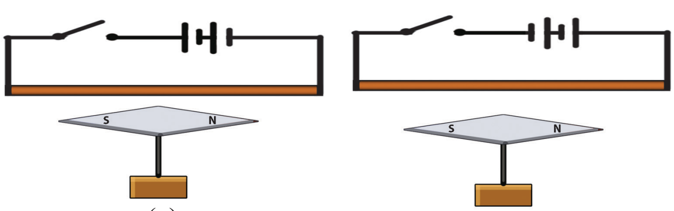


Fig. 4.33

7. Observe the diagrams [Fig. 4.34 (a), (b)].

   a) In both cases, does the north pole of the magnetic needle deflect clockwise or anticlockwise, when the switch is turned on?

   b) Justify your answer.



(a) Fig. 4.34 (b)

8. AB is a copper wire. An acrylic sheet is kept above the south pole of a magnet. Two copper wires are placed above the sheet in such a way that they are parallel. A battery and a switch are connected to the wires. AB is placed above them.

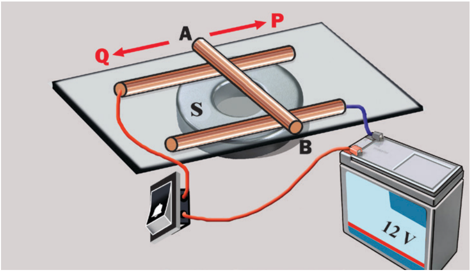


Fig. 4.35

   a) In which direction will the copper wire roll when the switch is turned on?

      (towards Q / towards P)

   b) What happens if the direction of the current is reversed?

9. Observe figure 4.36.

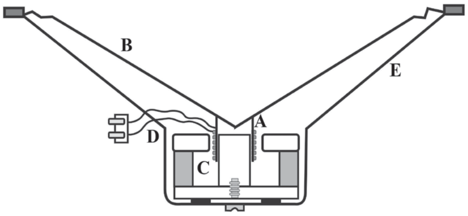


Fig. 4.36

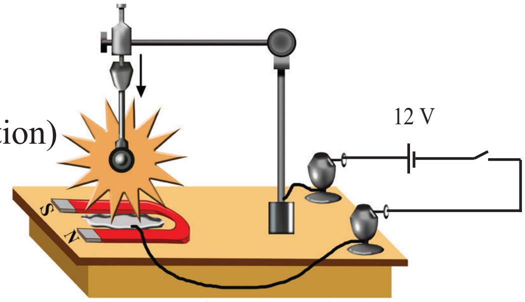
   a) Identify the device shown in the schematic diagram.
   b) What is its working principle?
   c) What is the energy conversion taking place in this device?
   d) Name the labelled parts.
   e) Name another device that works on the same principle.

10. A wooden block contains mercury between the north and south poles. A freely rotating toothed wheel is in contact with the mercury. When an electric current is passed through the wheel,

   a) in which direction is the wheel rotating?

      (clockwise direction / anti clockwise direction)

   b) Justify your answer.



Barlow's wheel

Fig 4.37

Extended activities

1. Construct and operate a device to prove the principle of a motor using two permanent magnets, a piece of copper wire, conducting wires, and a cell.
2. Dismantle a scrap loudspeaker. Identify its parts and arrange them on a paper with labels. Explain why the voice coil in it is very thin.

CONSTITUTION OF INDIA

Part IV A

FUNDAMENTAL DUTIES OF CITIZENS

ARTICLE 51 A

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

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

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

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

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

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

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

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

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

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

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

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

CHILDREN'S RIGHTS

Dear Children,

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

Let's see what your rights are:

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

Major Responsibilities

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

Contact Address:

Kerala State Commission for Protection of Child Rights
'Sree Ganesh', T. C. 14/2036, Vanross Junction
Kerala University P. O., Thiruvananthapuram - 34, Phone : 0471 - 2326603
Email: childrights.cpcr@kerala.gov.in, rte.cpcr@kerala.gov.in
Website : www.kescpcr.kerala.gov.in

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

Kerala Police Helpline - 0471 - 3243000/44000/45000

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