



# RAS

**Rajasthan Administrative Services**

**Rajasthan Public Service Commission**

**Volume - 11**

**General Science & Technology**



# GENERAL SCIENCE AND TECHNOLOGY

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# 2

## Chapter

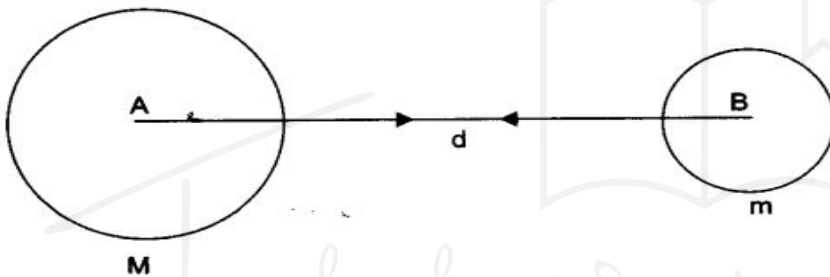
# Physics in everyday life

### Gravitation

- Force that attracts a **body towards centre** of earth, or **towards any other physical body** having mass.
- **Every object** that has **mass exerts a gravitational pull** or force on every other mass.
- **Strength** of this pull **depends on the masses of objects**
- **Gets weaker with distance.**
- **Keeps planets in orbit** around sun and moon around the Earth
- **First discovered** in 1687 by Sir Isaac **Newton**.

### Universal law of gravitation

- **Every object** in the universe **attracts every other object with a force** which is **proportional to the product** of their masses and **inversely proportional** to the **square** of the **distance** between them.
- The **force is along the line joining the centres of two objects.**



Gravitational force between two uniform objects is directed along the line joining their centres.

#### Formula:

$$F = G \frac{M \times m}{d^2}$$

- Here M and m = masses of the objects interacting
- d- distance between the center of the masses
- G -gravitational constant ( $6.674 \times 10^{-11} \text{ m}^3 \cdot \text{kg}^{-1} \cdot \text{s}^{-2}$ )

### Mass

- **Quantity of matter contained** in a **body**.
- A **scalar quantity**.
- **Unit - kilogram**.
- A body **contains the same quantity of matter whether** it be on the **earth, moon** or even in **outer space**. Thus, **mass is constant** and **does not change** from place to place.
- **Denoted** by the small letter '**m**'.
- **Cannot be zero**.

### Weight

- Measure of **force of gravity** acting on a body.
- **Formula** :  $w = mg$
- **Unit**- Newton (as it is a force).
- **Vector quantity**

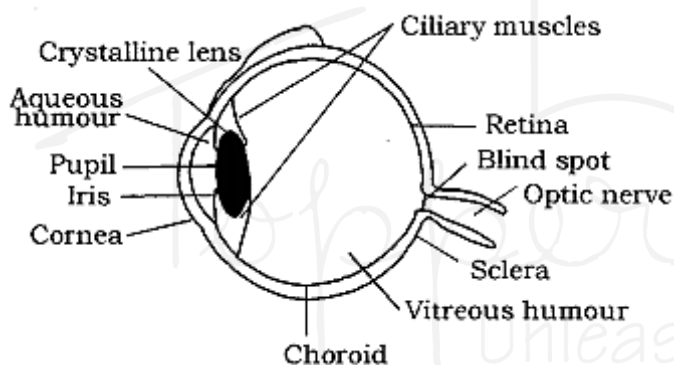
### Difference between Mass and Weight

Mass	Weight
<ul style="list-style-type: none"> <li>Quantity of matter possessed by a body</li> </ul>	<ul style="list-style-type: none"> <li>Force with which a <b>body</b> is attracted towards the centre of the earth.</li> </ul>
<ul style="list-style-type: none"> <li>Scalar quantity.</li> </ul>	<ul style="list-style-type: none"> <li>Vector quantity.</li> </ul>
<ul style="list-style-type: none"> <li>S.I. unit - kilogram (kg.)</li> </ul>	<ul style="list-style-type: none"> <li>S.I. unit - Newton (N).</li> </ul>
<ul style="list-style-type: none"> <li>Remains constant at all places</li> </ul>	<ul style="list-style-type: none"> <li>Changes from place to place.</li> </ul>
<ul style="list-style-type: none"> <li>Never zero.</li> </ul>	<ul style="list-style-type: none"> <li>Becomes zero at the centre of the earth.</li> </ul>
<ul style="list-style-type: none"> <li>Measured by a beam balance.</li> </ul>	<ul style="list-style-type: none"> <li>Measured by a spring balance.</li> </ul>

### Human eye and Defects

- Human Eye is a natural optical instrument which is used to see the objects by human beings.
  - It is like a camera which has a lens and screen system.

#### Structure of the Human Eye



#### The various parts of eye and their functions

Human Eye Part	Functions
Pupil	Opens and closes in order to regulate and control the amount of light.
Iris	Controls light level similar to the aperture of a camera.
Sclera	Protects the outer coat.
Cornea	A thin membrane which provides 67% of the eye's focusing power.
Crystalline lens	Helps to focus light into the retina.
Conjunctive	Covers the outer surface (visible part) of the eye.
Aqueous humour	Provides power to the cornea.
Vitreous humour	Provides the eye with its form and shape. powe

Retina	Captures the light rays focussed by the lens and sends impulses to the brain via the optic nerve.
Optic nerve	Transmits electrical signals to the brain.
Ciliary muscles	Contracts and extends in order to change the lens shape for focusing.

### Persistence of Vision:

- It is the time for which the sensation of an object continue in the eye.
- It is about 1/16th of a second.

### Power of Accommodation:

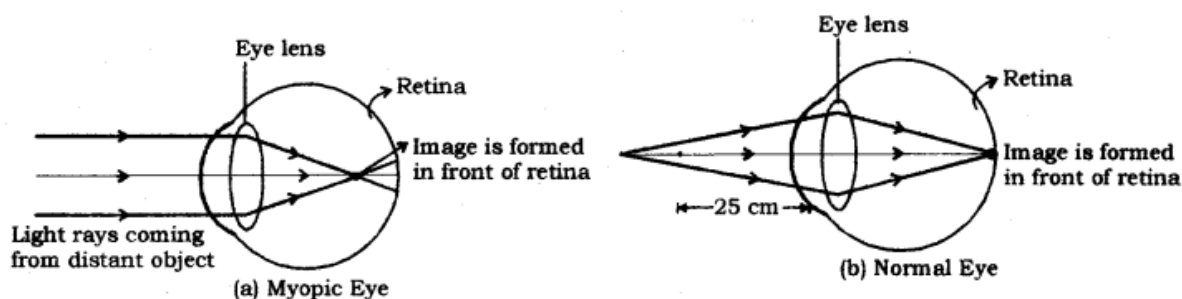
- The ability of the eye lens to adjust its focal length accordingly as the distances is called power of accommodation.

<b>Ciliary muscles</b>	
<b>Relaxed</b>	<b>Contract</b>
<ol style="list-style-type: none"> <li>1. Eye lens become thin.</li> <li>2. Increases the focal length.</li> <li>3. Enable us to see distant object clearly.</li> </ol>	<ol style="list-style-type: none"> <li>1. Eye lens become thick.</li> <li>2. Decreases the focal length.</li> <li>3. Enable us to see nearby object clearly.</li> </ol>
<b>Near point of the Eye</b>	<b>Far point of the Eye</b>
It is 25 cm for normal eye. The minimum distance at which object can be seen most distinctly without strain.	It is infinity for normal eye. It is the farthest point upto which the eye can see object clearly.

### Defects of Vision and their Correction

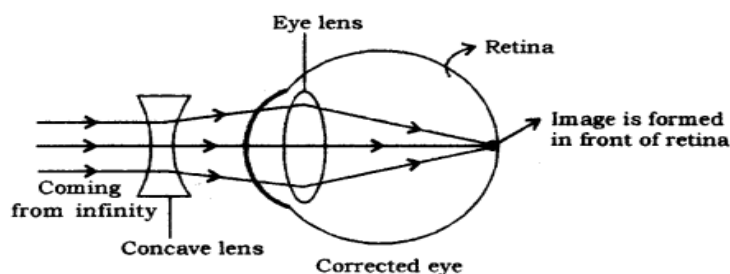
#### Myopia (Short-sightedness):

- A kind of defect in the human eye due to which a person can see near objects clearly but he cannot see the distant objects clearly. Myopia is due to
  - excessive curvature of the cornea.
  - elongation of eyeball.



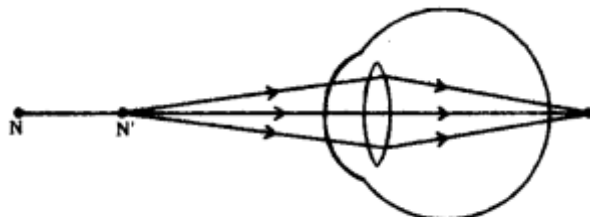
#### Correction

- Since a concave lens has an ability to diverge incoming rays, it is used to correct this defect of vision.
- The image is allowed to format the retina by using a concave lens of suitable power as shown in the given figure.



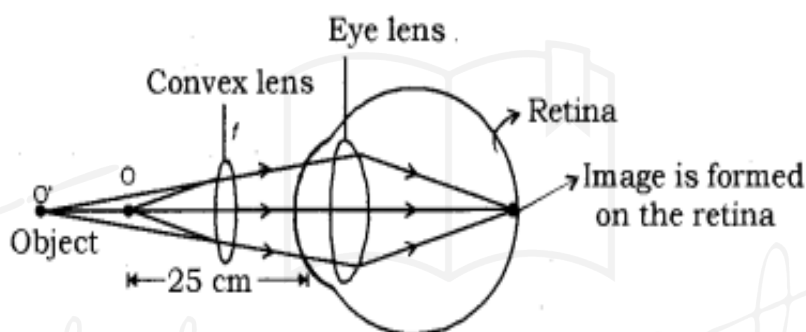
## Hypermetropia (Long-sightedness)

- It is a kind of defect in the human eye due to which, a person can see distant objects properly but cannot see the nearby objects clearly. It happens due to
  - decrease in the power of eye lens i.e., increase in focal length of eye lens.
  - shortening of eyeball.



**Hypermetropic eye**

- A hypermetropic eye has its least distance of distinct vision greater than 25 cm.
- **Correction:**
  - Since a convex lens has the ability to converge incoming rays, it can be used to correct this defect of vision.
  - The ray diagram for the corrective measure for a hypermetropic eye is shown in the given figure.



## Heat

- When water is boiled in a kettle the steam built up in the kettle raises its lid up and when the steam escapes out the lid falls down.
- Heat thus can do work, so, it is a form of energy.
- This property of steam was used to build steam engines – the devices which convert heat of steam into mechanical work.
- In fact work done against friction is always converted into heat.
- The equivalence of work and heat was noticed and experimentally established by J. P. Joule.
  - While boring the barrel of a gun with a blunt borer Joule found that so huge amount of heat was produced in the process that even water in which the process of boring was being carried out started boiling.
  - Through further experiments he found that one Calorie (Unit of heat prevalent at that time) of heat is equivalent to 4.2 Joule of work.

## Temperature

- A quantity which tells us how hot a body is.
- If a hot body is kept in contact with a colder body for some time, we will find that the hotter body does not remain that hot and the colder body becomes some what hotter.
- Thus heat is transferred from a hotter body (a body at higher temperature) to a Colder body (i.e. a body at lower temperature).
- Hence temperature is the degree of hotness of a body which determines the direction of flow of heat.
- Heat always flows from a body at higher temperature to a body at lower temperature.

## Effect of heat

- When a body is heated changes may occur in some of its properties .
- These changes are the effects of heat.



### Some of the effects of heat:

- Rise in temperature
  - When a body is heated its temperature increases, that is why, it appears warmer when touched.
- Change of state
  - When heat is supplied to a substance in solid state its temperature rises till at a particular temperature it may change into its liquid state without any further change in its temperature.
  - This characteristic constant temperature at which a solid changes into its liquid state is called melting point of the solid.
  - The melting point of a substance is a characteristic, constant value and different substances may have different values of melting points.
  - Conversion of a solid into its liquid state at its melting point is called change of state from solid to liquid (fusion) and the heat that is transferred to the substance during melting is called Latent Heat of Fusion.
    - Because, it does not become apparent in the form of rise in temperature.
  - Latent heat of fusion of a solid substance is defined as the amount of heat (in joules) required to convert 1kg of the substance from solid to liquid state at its melting point.
  - Similarly, when heat is supplied to a substance in liquid state its temperature rises but there is a possibility that it changes into its vapour state at a constant temperature.
    - The heat supplied in this case is called Latent Heat of Vaporization.
  - Latent heat of vaporization of a liquid is defined as the amount of heat (in joules) required to convert 1kg of the substance from its liquid to gaseous state at a constant temperature.
  - Vaporization may take place in two different ways:
    - Evaporation from the surface of a liquid at any temperature
    - Boiling of the whole mass of the liquid at a constant temperature called boiling point of the liquid.

S. No.	Name of Material	Melting Point (°C)	Latent heat of fusion ( $\times 10^3$ J/kg)	Boiling Point (°C)	Latent heat of vaporization ( $\times 10^3$ J/kg)
1.	Helium	-271	-	-268	25.1
2.	Hydrogen	-259	58.6	-252	452
3.	Air	-212	23.0	-191	213
4.	Mercury	-39	11.7	357	272
5.	Pure Water	0	335	100	2260
6.	Aluminum	658	322	1800	-
7.	Gold	1063	67	2500	-

### Static and Current Electricity

- A controllable and convenient **form of energy** used in homes, schools, hospitals, industries, etc for operating devices.

**We will write down the differences between the two on a number of factors in the form of a table.**

Basis of difference	Static electricity	Electric current
Material	It can be developed on any type of material, either it be conductor or an insulator.	The current is produced only in conductors as it is due to movement of electrons.

Time period	Time period is short, as it exists for a very short period of time.	A comparative long time period.
Measuring device	It can be measured with a Gold leaf electroscope.	It can be measured with an Analog or a Digital meter.
Magnetic Field	Static electricity doesn't induce any magnetic field.	A magnetic field is induced every time an electric current is produced.
Example	Lightning in the sky etc.	It can be seen in electrical equipment like TV, bulb etc.

### Electric charge:

- **Fundamental unit of electricity** (without charge, no electricity).
- **2 types:** Positive & Negative.
- **SI Unit:** Coulomb

### Electric current:

- **Rate of flow of electric charges.**
- **Caused by moving electrons** through a conductor.
- **Flows in the opposite direction** to the **movement of electrons.**

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

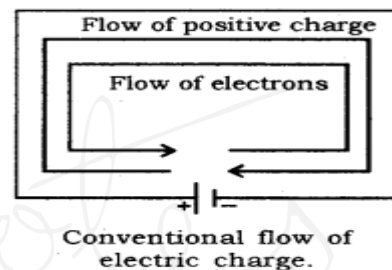
Where,

I= Electric current

Q= Electric charge

t= time

- **Unit** - ampere (A)
- **Measured:** Ammeter



### Electric circuit

- **Closed conducting path** through which **current flows.**

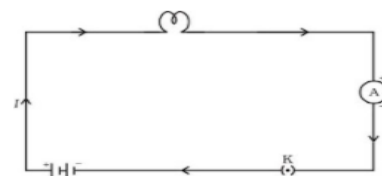
#### Potential Difference:

- **Work done to move a unit charge from one point to the other** within an electric field..

$$V = \frac{W}{Q}$$

- **SI unit:** volt (V)

- **When the cell is connected to a conducting circuit element,** the potential difference sets the charges in motion in the conductor and produces an electric current.



### OHM'S LAW:

- **Potential difference between two points is directly proportional to electric current,** at a constant temperature.

$$V \propto I$$

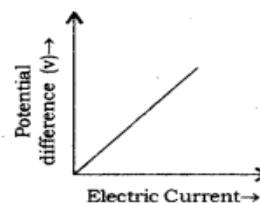
$$V = RI$$

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

- Here, R is the constant k/a resistance.

#### Resistance:

- **Property of a conductor to resist flow of charges** through it.
- **SI Unit:** Ohm ( $\Omega$ ).



### 1 Ohm of resistance (R)

Equal to flow of 1A of current through a conductor between two points having a potential difference equal to 1V.

### Factors on which Resistance of a Conductor depends:

1. **Nature of Material:**
  - **Conductors & insulators.**
  - **Silver** - best conductor of electricity.
2. **Length of Conductor:**
  - **Resistance increases** with **increase** in **length** of the conductor.
3. **Area of Cross Section:**
  - **Resistance decreases** with an **increase** in **area** of conductor and **vice versa**.

### Resistivity:

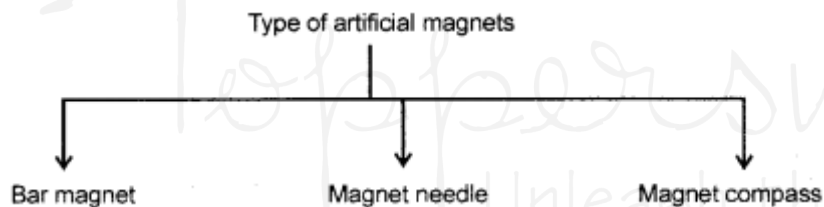
- **Resistance offered by a cube of a material** of side 1m **when current flows perpendicular to its opposite faces.**
- **SI unit** - ohm-meter ( $\Omega m$ ).
- **aka** specific resistance.
- **Depends** on the **nature** of the **material** of the conductor.
- **Varies** with **temperature**.

### Heating Effect of Electric Current:

- **When electric current passes** through a **purely resistive conductor**, **energy** of electric current is **dissipated** entirely in the **form of heat** and as a result, **resistor gets heated**.
- **Eg.** light bulb

## Magnetism

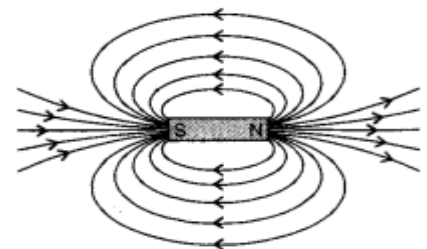
### Magnet:



- An **object that attracts objects** made of **iron, cobalt and nickel**.
- **Use:**
  - in refrigerators.
  - in radio and stereo speakers.
  - in audio and video cassette players.
  - in children's toys and;
  - on hard discs and floppies of computers.
- **Properties:**
  - A **freely suspended magnet** always **points** towards **north** and **south** direction.
  - **Pole** which points **toward north** direction - **north pole**.
  - **Pole** which points **toward south** direction - **south pole**.
  - **Like poles repel** each other while **unlike poles attract** each other.

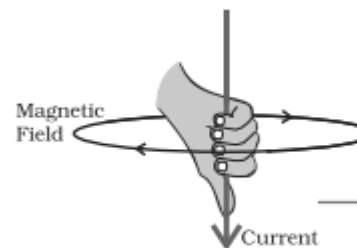
### Magnetic field:

- **Influence of force surrounding a magnet.**
- **Force exerted** by a magnet in a magnetic field **detected** using a **compass** or any **other magnet**.
- **Represented** by **magnetic field lines**.
- A **quantity** that has **both direction** and **magnitude**.
- **Properties:**
  - **Inside magnet** - direction of field lines- **south pole to north pole**. Thus magnetic field lines are **closed curves**.
  - **Relative strength** of magnetic field is **shown** by degree of **closeness of field lines**.
  - **No two field-lines** cross each other.



### Fleming's Right-Hand Thumb Rule:

- If a **current carrying conductor** is held by right hand, keeping thumb straight and if the **direction of electric current** is in **direction of thumb**, then **direction of wrapping of other fingers** will show the **direction of magnetic field**.



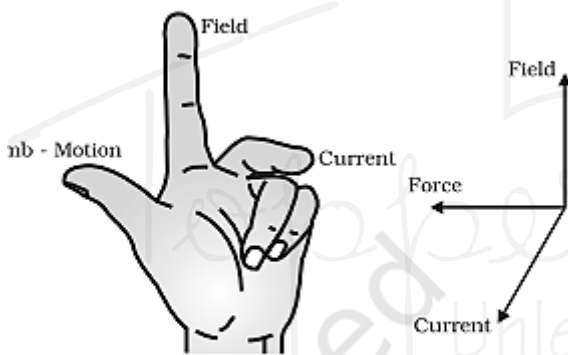
**Figure 13.7**  
Right-hand thumb rule

### Electromagnetism

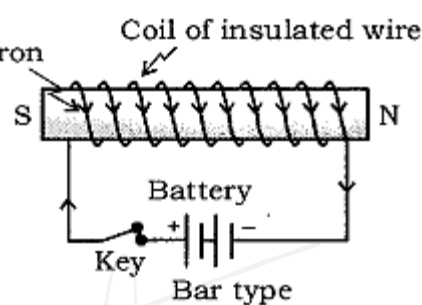
- A phenomenon in which a magnetic field is generated with the help of the current in the conductor.
- Made of two different aspects - electricity and magnetism.
- Electricity and magnetism were considered as different and separate forces up until the 19th century.
- After more research, they were regarded as interrelated phenomena due to Einstein's Special Theory of Relativity.
- With the help of this theory we can understand that even though both electricity and magnetism possess varying properties, they are still defined by one common phenomenon.
- Electric charges help produce electric forces at rest or while in motion. Meanwhile, magnetic forces can only be formed when there exists a motion of charged particles.

### Electromagnet:

- Consists of a **long coil of insulated copper wire** wrapped on a **soft iron**.
  - **Formed by producing magnetic field inside a solenoid.**
- Fleming's left-hand rule:

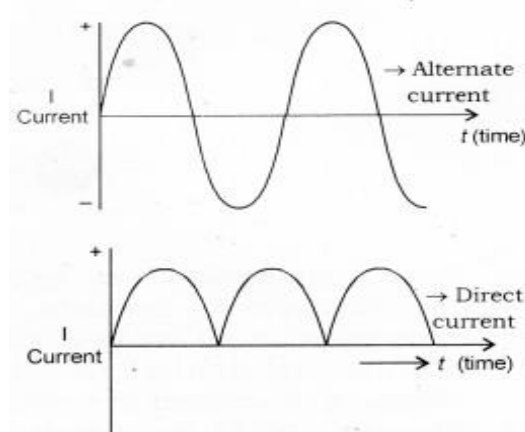
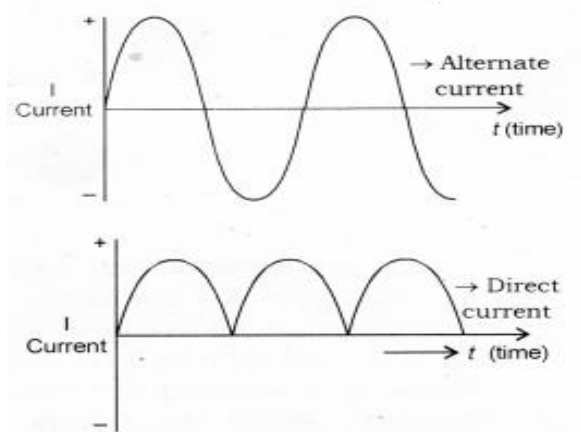


**Figure 13.13**  
Fleming's left-hand rule



- If the **left hand** is stretched in a way that the **index finger**, **middle finger** and **thumb** are in **mutually perpendicular directions**, then **index finger** and **middle finger** of a stretched left hand show **direction of magnetic field** and **direction of electric current** respectively and the **thumb** shows the **direction of motion or force** acting on the conductor.

### Alternate Current:



- **Current in which direction is changed periodically.**
- **Frequency of A.C in India is 50 Hz.**
- **Transmitted to a long distance without much loss of energy.**

### Direct Current:

- **Current that flows in one direction only.**
- **Electrochemical cells produce direct current.**

#### Advantages of A.C over D.C

- **Cost of generator of A.C << D.C.**
- **A.C easily converted to D.C.**
- **A.C controlled by use of choke - less loss of power whereas, D.C controlled using resistances - high energy loss.**
- **AC transmitted over long distances without much loss of energy.**
- **AC machines are stout and durable and do not need much maintenance.**

#### Disadvantages of AC

- Cannot be used for electrolysis or showing electromagnetism as it reverses its polarity.
- More dangerous than DC.

## Sound

A form of energy which produces a sensation of hearing in our ears.

### Production of Sound

- Sound is produced due to the vibration of objects.
- Vibration is a periodic back-and-forth motion of the particles of an elastic body or medium about a central position. It is also named as oscillation.
- Eg:
  - Stretched strings of a guitar vibrate to produce sound.
  - When membrane of a table is struck, it vibrates to produce sound.

### Propagation of Sound

- The travelling of sound is called propagation of sound.
- Sound is propagated by the to and fro motion of particles of the medium.
- When an object vibrates, the particles around the medium vibrate.
- The particle in contact with the vibrating object is first displaced from its equilibrium position.
- Each particle disturbs the other particle in contact.
- Thus, the disturbance is carried from the source to the listener.
- Only the disturbance produced by the vibrating body travels through the medium but the particles do not move forward themselves.

### Medium

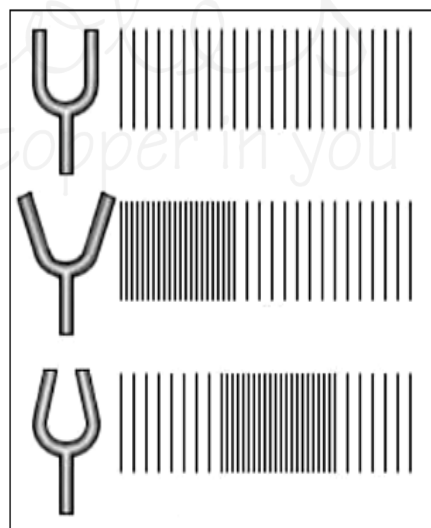
- The matter or substance through which sound is transmitted is called a medium.
- A medium is necessary for the propagation of sound waves.
- The medium can be solid, liquid or gas.
- Sound cannot travel in vacuum.

## Wave

- Wave is a phenomenon or disturbance in which energy is transferred from one point to another without any direct contact between them.
- For example: Heat, light and sound is considered as a wave.

### Types of Waves

- **Longitudinal waves:** These are the waves in which the particles of the medium vibrate along the direction of propagation of the wave. For example: sound wave.
- **Transverse waves:** In this type of wave the particles of the medium vibrate in a direction perpendicular to the direction of propagation of the wave. For example: waves produced in a stretched string.
- Another type of waves which do not require any medium for propagation are called electromagnetic waves.
  - These waves can travel through vacuum also.
    - For example, light waves, X-rays.



**Fig. Representation of particle disturbance moving forward**