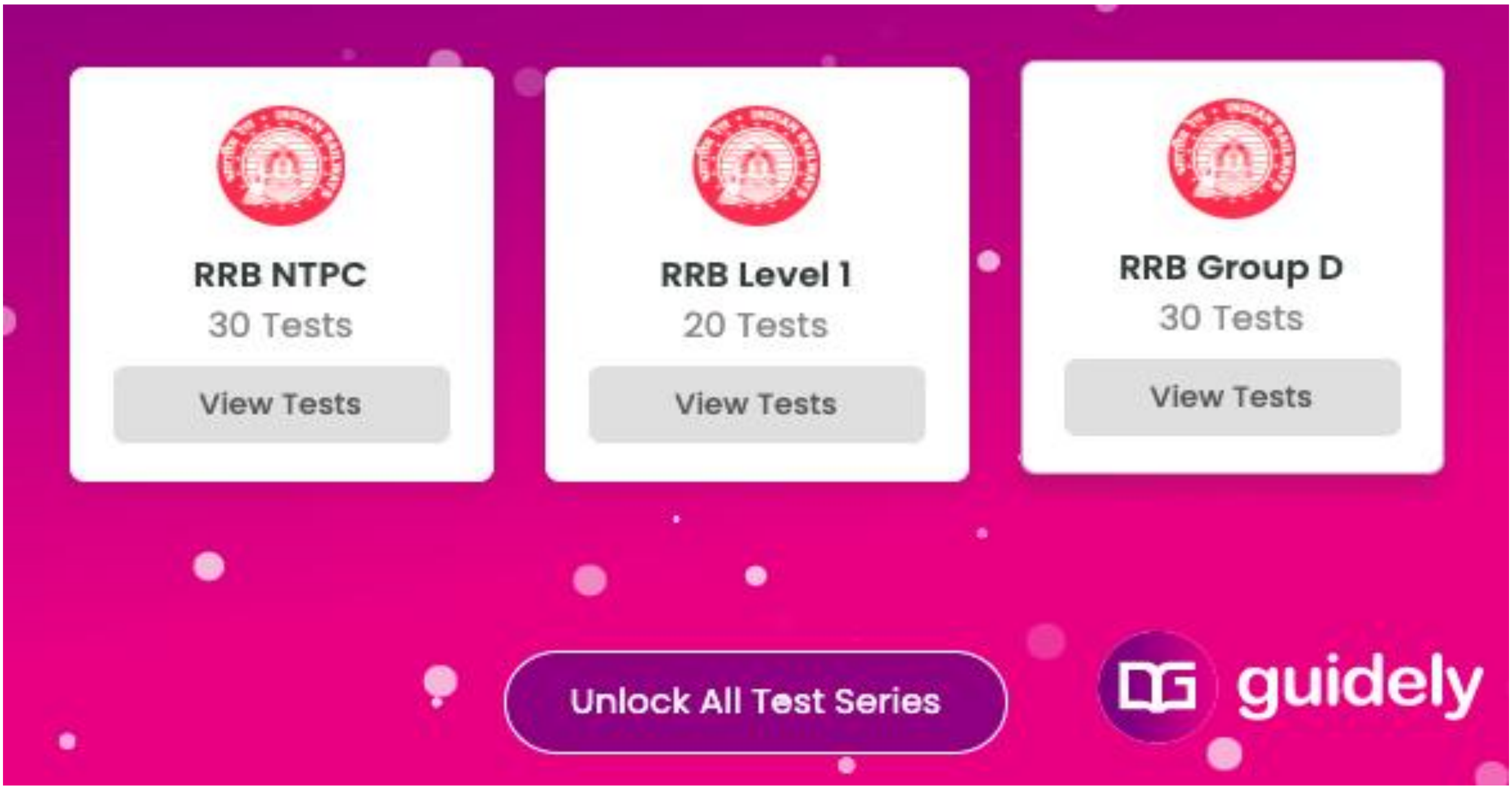

General Science - Physics

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Units and Measurements

UNIT

A unit is defined as a standard or fixed quantity of one kind used to measure other quantities of the same kind

- Fundamental units and derived units are the two classifications of units
- **Fundamental units**: Quantities which cannot be expressed in terms of any other physical quantities are called fundamental quantities. The units used to measure the fundamental quantities are called fundamental units Example: Length, mass, time, temperature etc.
- **Derived units:** Units which are derived from basic units and bear a constant relationship with fundamental units. Examples are area, volume, pressure, force, etc.

INTERNATIONAL SYSTEM OF UNITS

In earlier time scientists of different countries were using different systems of units for measurement. Three such systems are CGS, FPS and MKS. Base units for length, mass and time in these systems were as follows

- FPS system: The basic units of length, mass and time are measured in foot, pound and second respectively
- CGS system: The basic units of length, mass and time are measured in centimeter, gram and seconds respectively
- MKS system: The basic units of length, mass and time are measured in metre, kilogram and second respectively
- S.I. units are referred to as Systems International units

FUNDAMENT UNITS OF FPS, CGS, MKS AND SI UNITS

S.No	Basic quantity	FPS	CGS	MKS	SI Units
1	Length	Foot	Centimetre	Metre	Metre
2	Mass	Pound	Gram	Kilogram	Kilogram
3	Time	Second	Second	Second	Second
4	Current	Ampere	Ampere	Ampere	Ampere
5	Temperature	Fahrenheit	Centigrade	Centigrade	Kelvin
6	Light intensity	Candela	Candela	Candela	Candela

SI BASE QUANTITIES AND UNITS

- There are seven fundamental units in the SI system of units. They are also known as base units

Quantity	SI Unit	Symbol
Length	Metre	M
Mass	Kilogram	Kg
Time	Second	S
Electric current	Ampere	A
Thermo dynamic temperature	Kelvin	K
Amount of substance	Mole	Mol
Luminous intensity	Candela	Cd

SI DERIVED UNITS

S.No	Quantity	SI Unit
1	Area	Square metre
2	Volume	Cubic metre
3	Velocity	Metre/second
4	Acceleration	Metre/second square
5	Density	Kilogram/metre Cube
6	Work	Joule
7	Energy	Joule
8	Force	Newton
9	Weight	Newton
10	Pressure	Pascal
11	Frequency	Hertz
12	Power	Watt
13	Impulse	Newton-second
14	Angular velocity	Radian /second
15	Electric charge	Coulomb
16	Electric potential(voltage)	Volt
17	Capacitance	Farad
18	Inductance	Henry
19	Resistance	Ohm
20	Impedance	Ohm

21	Reactance	Ohm
22	Electrical conductance	siemens
23	Magnetic flux	Weber
24	Magnetic flux density	Tesla
25	Heat	Joule
26	Angle	Radian
27	Radioactivity	Becquerel
28	Luminous flux	Lumen
29	Momentum	kilogram meter per second
30	Torque	Newton metre
31	Specific heat	Joule per kilogram kelvin

SI Prefixes Used with Units in Physics

- Unit prefixes are the symbols placed before the symbol of a unit to specify the order of magnitude of the quantity. They are useful to express very large and very small quantities. k (kilo) is the unit prefix in the unit, kilometer. A unit prefix stands for a specific positive or negative power of 10

Name	**Factor**
Femto	10^{-15}
Pico	10^{-12}
Nano	10^{-9}
Micro	10^{-6}
Milli	10^{-3}
Centi	10^{-2}

Deci	10^{-1}
Deka	10
Hector	10^{2}
Kilo	10^{3}
Mega	10^{6}
Giga	10^{9}
Tera	10^{12}
Peta	10^{15}

IMPORTANT POINTS

- 1 fermi = 10^{-15} m
- 1 angstrom = 1 Å = 10^{-10} m
- Speed of the light in vacuum is 3.00 × 10^{8} **m/s**
- **Astronomical unit (AU):** It is the mean distance of the centre of the Sun from the centre of the Earth.
- 1 astronomical unit = 1.496 × 10^11 m
- **Light year** is a unit of length used to express astronomical distances.
- Light year=9.46 × 10^{15} m
- **Parsec:** Parsec is the unit of distance used to measure astronomical objects outside the solar system.
- 1 Parsec = 3.08 × 10^{16} m
- 1 Parsec = 3.26 light year.
- **Time** is a measure of duration of events and the intervals between them. The SI unit of time is second.
- Heat is a form of energy. Temperature is the degree of hotness or coldness of a body. The relationship for conversion from one temperature scale to the others is

$$\frac{^0R}{80} = \frac{^0C}{100} = \frac{^0K - 273}{100} = \frac{^0F - 32}{180}$$

- **Mass**: Mass is the quantity of matter contained in a body. The SI unit of mass is kilogram (kg).
  1 g = 1/1000 × 1 kg = 0.001 kg
  1 mg = 1/1000000 × 1 kg = 0.000001 kg
  1 quintal = 100 × 1 kg = 100 kg

1 metric tonne = 1000 × 1 kg = 10 quintal

- Mass of 1 ml of **water** = 1g
  Mass of 1l of **water** = 1kg
  Mass of the **other liquids** vary with their **density**.
- **Atomic mass unit:** Mass of a proton, neutron and electron can be determined using atomic mass unit (amu).
  1 amu = (1/12)th of the mass of C^{12} atom

Measurement of length

- Metre scale is used for lengths from 10^{-3} m to 10^{2} m
- Verniercalliper is used for lengths to an accuracy of 10^{-4} m
- Screw gauge and a spherometer can be used to measure lengths as less as to 10^{-5}m

LIST OF SCIENTIFIC INSTRUMENTS AND THEIR USES

S.No	Instrument	Uses
1	Altimeter	Measures altitude. It's used in aircrafts
2	Ammeter	Measures strength of electric current
3	Anemometer	Used for measuring wind speed and direction
4	Audiometer	Measures Intensity of Sound
5	Barograph	Continuous recording of atmospheric pressure
6	Barometer	Measures atmospheric pressure
7	Binoculars	Optical instrument used for magnified view of distant object
8	Bolometer	To measure heat Radiation
9	Callipers	Measure diameter of thin cylinder or wire
10	Calorimeter	Measures quantities of heat
11	Cardiogram	Traces movements of the heart and recorded on a Cardiograph

12	Colorimeter	Compares Intensity of colours
13	Commutator	Used in generators to reverse the direction of electric current
14	Crescograph	Used to measure the growth of plants
15	Cryometer	Used to measure very low temperatures
16	Dynamometer	Measures electrical power
17	Electroscope	It detects presence of an electric charge
18	Endoscope	To examine internal parts of the body
19	Fathometer	Measure depth of the ocean
20	Galvanometer	Measures electric current
21	Hydrometer	Instrument used for measuring the relative density of liquids
22	Hygrometer	It measures humidity of air
23	Hydrophone	Measures sound under water
24	Lactometer	It determines the purity of milk
25	Microscope	To obtain a magnified view of small objects
26	Photometer	The instrument Compares the luminous intensity of the source of light.
27	Pyrometer	Measure very high temperature especially in furnaces and kilns
28	Odometer	The instrument used for measuring the distance traveled by a vehicle such as a bicycle or car
29	Ohmmeter	The electrical instrument that measures electrical resistance

30	Periscope	It is used to view object above the sea level
31	Salinometer	It determines the salinity of solutions
32	Sphygmometer	It measures the blood pressure
33	Stroboscope	To view rapidly moving objects
34	Seismograph	The instrument used to detect and record earthquakes
35	Telescope	Used for magnified view of distant objects
36	Spectrometer	Properties of light

MOTION

- Motion is a change of position it can be described in terms of the distance moved or the displacement.
- When a body does not change its position, with respect to its surroundings, it is said to be at rest. When a body changes its position, with respect to its surroundings, it is said to be in motion
- The motion of an object could be uniform or non-uniform depending on whether its velocity is constant or changing.
- **Uniform motion:** An object is said to be in uniform motion if it covers equal distances in equal intervals of time howsoever big or small these time intervals may be.
- **Non-uniform motion:** An object is said to be in non-uniform motion if it covers unequal distances in equal intervals of time.

Scalar and vector

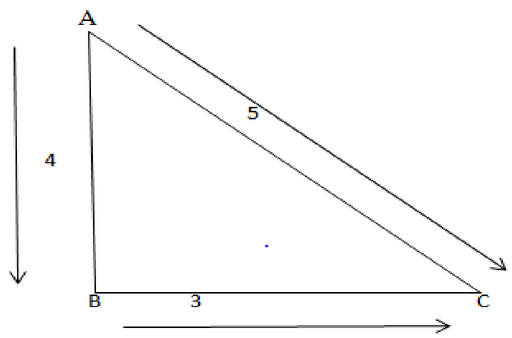
SCALAR	VECTOR
A scalar is a quantity with magnitude only	A vector is a quantity with the magnitude as well as direction

Examples are Length, Area, Distance, Speed, Mass, Density, Pressure, etc..	Examples are Displacement, Velocity, Acceleration, momentum, Force

Distance and displacement

- **Distance** The actual length of the path travelled by a moving body irrespective of the direction is called the distance travelled by the body. It is measured in metre in SI system. It is a scalar quantity having magnitude only.
- **Displacement:** It is defined as the change in position of a moving body in a particular direction. It is a vector quantity having both magnitude and direction. It is also measured in metre in SI system.

DISTANCE	DISPLACEMENT
Distance of the object can be defined as the complete path travelled by on object during its motion	Displacement of the object can be defined as the overall motion of the object or minimum distance between the starting point of the object and the final position of the object
Distance is a scalar quantity	Displacement is a vector quantity
Distance of the any object does not depend on the direction of its motion	Displacement of the any object depends on the direction of its motion



- **Distance** is refers to how much ground an object has covered during its motion(A -→ B→C) Distance=4+3=7
- **Displacement** is a to refers to "how far out of place an object is("A→C) Displacement=5
- **Distance** gives the complete information about the path travelled by the object
- **Displacement** does not gives the complete information about the path travelled by the object

Speed, Velocity and Acceleration

- **Speed**: Speed is the rate of change of distance or the distance travelled in unit time. It is a scalar quantity.
  Speed = Distance travelled / Time
- Speed is scalar quantity and unit is m/s
- Speed of objects help us to decide which one is moving faster than the other.
- **Velocity**: Velocity is the rate of change of displacement. It is the displacement in unit time. It is a vector quantity.
  Velocity = Displacement / Time
- Velocity is vector quantity and unit is m/s
- During **uniform motion** of an object along a straight line, the velocity remains constant with time. In this case, the change in velocity of the object for any time interval is zero.
- During **non-uniform motion**, velocity varies with time. It has different values at different instants and at different points of the path. Thus, the change in velocity of the object during any time interval is not zero. This phenomenon is called acceleration

- **Acceleration :** Acceleration of an object is the change in velocity per unit time
- Unit of acceleration is m/s^2
- Acceleration is vector quantity

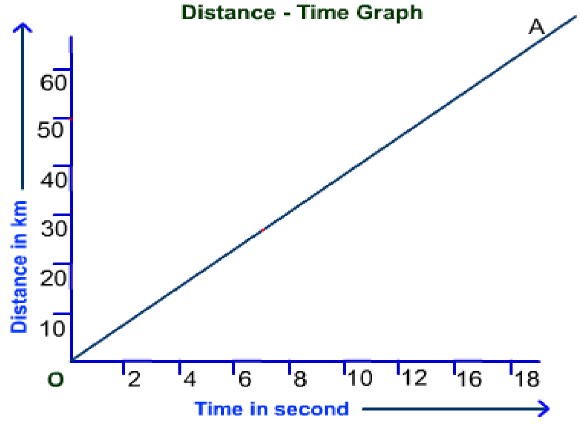
  Acceleration= Change in velocity/time
  Acceleration= (Final velocity – Initial velocity)/Time
  $a = (v–u) /t$

  From the above equation

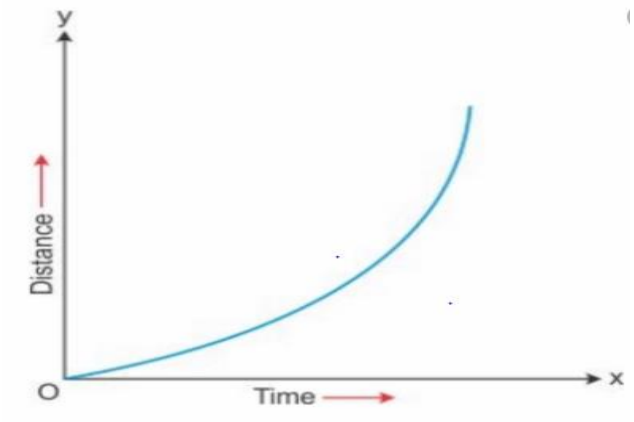
  1. If v > u, i.e. if final velocity is greater than initial velocity, the velocity increases with time and the value of acceleration is positive.
  2. If v < u, i.e. if final velocity is less than initial velocity, the velocity decreases with time and the value of acceleration is negative. It is called negative acceleration. Negative acceleration is called retardation or deceleration

Graphical Representation of Motion

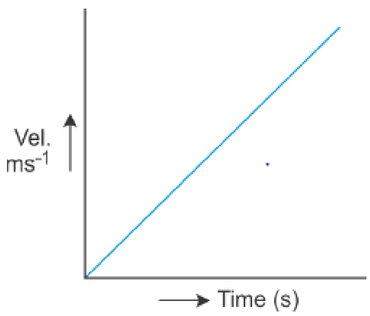
- **The distance – time graph for Uniform motion**



- **The distance time graph for Non-uniform motion**



- **Velocity-time graph for a body having uniform acceleration**
The nature of the graph shows that velocity changes by equal amounts in equal intervals of time. Thus, for all uniformly accelerated motion, the velocity-time graph is a straight line.



- In the case of non-uniformly accelerated motion, velocity-time graphs can have any shape.

EQUATIONS OF MOTION

- When an object moves along a straight line with uniform acceleration, it is possible to relate its velocity, acceleration during motion and the distance covered by it in a certain time interval by a set of equations known as the **equations of motion**. Such equations are

$$v = u + at$$
$$s = ut + \frac{1}{2} at^2$$
$$2as = v^2 - u^2$$

Where u-is the initial velocity
v-is the initial velocity
a -Acceleration
s- Displacement
t=Time of motion

MOTION OF FREELY FALLING BODY

- When all objects are dropped in the absence of air medium (vacuum), all would have reached the ground at the same time.
- In air medium, air offers some resistance to the motion of freely falling objects. But, it is negligibly small when compared to the gravitational pull. Hence, they reach the ground at the same time.
- All Objects experiences acceleration during free fall. This acceleration experienced by an object is independent of mass. This means that all objects hollow or solid, big or small, should fall at the same rate.
- The equation of motion for a freely falling body can be obtained by replacing 'a' in equations with g, the acceleration due to gravity. For a freely falling body which is initially at rest, u = 0. Thus we get the following equations.
  $v = gt$
  $s = \frac{1}{2} gt^2$
  $v^2 = 2gh$
- When we throw an object vertically upwards, it moves against the acceleration due to gravity. Hence, 'a' is taken to be –g and when moving downwards 'a' is taken as +g

UNIFORM CIRCULAR MOTION

- If an object moves in a circular path with uniform speed, its motion is called uniform circular motion

- There are many more familiar examples of objects moving under uniform circular motion, such as the motion of the moon and the earth, a satellite in a circular orbit around the earth, a cyclist on a circular track at constant speed and so on

Important points

- The state of motion of an object is described by its **speed and the direction of motion.** The state of rest is considered to be the state of zero speed. An object may be at rest or in motion both are its states of motion
- When a body is thrown vertically upwards in space, at the highest point, the body has zero velocity but it has acceleration due to the gravity.

FORCE AND LAWS OF MOTION

FORCE

- In science, a push or a pull on an object with mass that causes it to change velocity is called a force. Force has **magnitude** as well as **direction**
- Force acting on an object may cause a change in its state of motion or a change in its shape
- Forces applied on an object in the **same direction add to one another**
- Forces act in the opposite directions on an object, the net force acting on it is the difference between the two forces
- **Balanced and unbalanced forces**

  Balanced forces do not cause any change in motion whereas unbalanced forces does
- Objects or things fall towards the earth because it pulls them. This force is called the force of gravity, or just gravity. This is an attractive force. The force of gravity acts on all objects. The force of gravity acts on all of us all the time without our being aware of it. Water begins to flow towards the ground as soon as we open a tap. Water in rivers flows downward due to the force of gravity.

> Gravity is not a property of the earth alone. In fact, every object in the universe, whether small or large, exerts a force on every other object. This force is known as the gravitational force.

- **Nuclear force** is the strongest force in the nature
- The force exerted by a charged body on another charged or uncharged body is known as **electrostatic force**. This force comes into play even when the bodies are not in contact
- Body is said to be a equilibrium if sum of all the forces acts on the body is **zero**. In other words if it is at rest or moving with uniform velocity

State of Motion

- The state of motion of an object is described by its speed and the direction of motion. The state of rest is considered to be the state of zero speed. An object may be at rest or in motion; both are its states of motion.

- The force acting on a unit area of a surface is called pressure.
  Pressure = force / area on which it acts
- Liquids and gases exert pressure on the walls of their containers.
- The pressure exerted by air around us is known as atmospheric pressure.

INERTIA

- The inherent property of a body to resist any change in its state of rest or the state of uniform motion, unless it is influenced upon by an external unbalanced force, is known as 'inertia'.

Types of Inertia

Inertia of rest

- The resistance of a body to change its state of rest is called inertia of rest
- **Example:** When you vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down

Inertia of direction

- The resistance of a body to change its direction of motion is called inertia of direction
- **Example:** When you make a sharp turn while driving a car, you tend to lean sideways

Inertia of motion

- The resistance of a body to change its state of motion is called inertia of motion
- **Example:** An athlete runs some distance before jumping. Because, this will help him jump longer and higher.

LINEAR MOMENTUM

- The product of mass and velocity of a moving body gives the magnitude of linear momentum. It acts in the direction of the velocity of the object.
  Linear Momentum = mass × velocity
  $p = mv$
- Linear momentum is a vector quantity.
- The linear momentum measures the impact of a force on a body.

IMPULSE

- When a force F acts on a body for a period of time t, then the product of force and time is known as 'impulse'
  Impulse = $F \times t$

NEWTON'S LAWS OF MOTION

First Law of Motion

- The first law of motion is stated as **"An object remains in a state of rest or of uniform motion in a straight line unless compelled to change that state by an applied force "**
- All objects resist a change in their state of motion. In a qualitative way, the tendency of undisturbed objects to stay at rest or to keep moving with the same velocity is called inertia. This is why, the first law of motion is also known as the **law of inertia**
- Inertia is the natural tendency of an object to resist a change in its state of motion or of rest. The mass of an object is a measure of its inertia. Its SI unit is kilogram

Galileo Galilei

- Galileo Galilei was born on 15 February 1564 in Pisa, Italy. Galileo, right from his childhood, had interest in mathematics and natural philosophy. But his father Vincenzo Galilei wanted him to become a medical doctor. Accordingly, Galileo enrolled himself for a medical degree at the University of Pisa in 1581 which he never completed because of his real interest in mathematics. In 1586, he wrote his first scientific book 'The Little Balance [La Balancitta]', in which he described Archimedes' method of finding the relative densities (or specific gravities) of substances using a balance.
- In 1589, in his series of essays – De Motu, he presented his theories about falling objects using an inclined plane to slow down the rate of descent.
- In 1592, he was appointed professor of mathematics at the University of Padua in the Republic of Venice. Here he continued his observations on the theory of motion and through his study of inclined planes and the pendulum, formulated the correct law for uniformly accelerated objects that the distance the object moves is proportional to the square of the time taken. Galileo was also a remarkable craftsman. He developed a series of telescopes whose optical performance was much better than that of other telescopes available during those days. Around 1640, he designed the first pendulum clock. In his book 'Starry Messenger' on his astronomical discoveries, Galileo claimed to have seen mountains on the moon, the milky way made up of tiny stars, and four small bodies orbiting Jupiter. In his books 'Discourse on Floating Bodies' and 'Letters on the Sunspots', he disclosed his observations of sunspots. Using his own telescopes and through his observations on Saturn and Venus, Galileo argued that all the planets must orbit the Sun and not the earth, contrary to what was believed at that time.

Second Law of Motion

- The second law of motion states that **the rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of force**

- The SI unit of force is kg m s^{-2}. This is also known as newton and represented by the symbol N. A force of one newton produces an acceleration of 1 m s^{-2} on an object of mass 1 kg
- The second law of motion gives a method to measure the force acting on an object as a product of its mass and accelerations

F=ma

- The momentum, p of an object is defined as the product of its mass, m and velocity, v. That is p=mv
- Momentum has both direction and magnitude. Its direction is the same as that of velocity, v. The SI unit of momentum is kilogram-metre per second
- Real time example is a fielder pulls his hand backward while catching a cricket ball coming with a great speed to reduce the momentum of the ball with a little delay.In doing so the fielder increases the time during which the high velocity of the moving ball decreases to zero. Thus the acceleration of the ball is decreased and therefore the impact of catching the fast moving ball is also reduced
- In a high jump athletic event the athletes are made to fall either on a cushioned bed or on a sand bed. This is to increase the time of the athlete's fall to stop after making the jump. This decreases the rate of change of momentum and hence the force. This prevents the athlete from getting hurt

Third Law of Motion

- The third law of motion states **To every action, there is an equal and opposite reaction and they act on two different bodies**
- If a body A applies a force F_A on a body B, then the body B reacts with force F_B on the body A, which is equal to FA in magnitude, but opposite in direction. $F_B = -F_{As}$

Examples

- Real time example is when a gun is fired it exerts a forward force on the bullet. The bullet exerts an equal and opposite force on the gun. This results in the recoil of the gun . Since the gun has a much greater mass than the bullet, the acceleration of the gun is much less than the acceleration of the bullet
- Third law of motion is another example is when a sailor jumps out of a rowing boat. As the sailor jumps forward, the force on the boat moves it backwards
- When birds fly they push the air downwards with their wings (Action) and the air pushes the bird upwards (Reaction).
- Motion of rocket

CONSERVATION OF MOMENTUM

- Sum of momenta of the two objects before collision is equal to the sum of momenta after the collision provided there is no external unbalanced force acting on them. This is known as the law of conservation of momentum
- In an isolated system (where there is no external force), the total momentum remains conserved

ROCKET PROPULSION

- Propulsion of rockets is based on the law of conservation of linear momentum as well as Newton's third law of motion.
- Rockets are filled with a fuel (either liquid or solid) in the propellant tank. When the rocket is fired, this fuel is burnt and a hot gas is ejected with a high speed from the nozzle of the rocket, producing a huge momentum. To balance this momentum, an equal and opposite reaction force is produced in the combustion chamber, which makes the rocket project forward

PRESSURE

- The effect of force can be measured using a physical quantity called **pressure**. It can be defined as the amount of force or thrust acting perpendicularly on a surface of area of one square meter of a body.
  Pressure = Thrust (or) Force/ Area
  The SI unit of pressure is pascal
- Pressure exerted by a force depends on the magnitude of the force and the area of contact.
- The effect of pressure can be increased by increasing the thrust or by decreasing the surface area of the body

Atmospheric pressure

- The amount of force or weight of the atmospheric air that acts downward on unit surface area of the surface of the Earth is known as atmospheric pressure.
- It can be measured using the device called **barometer.**
- The barometer was invented by **Torricelli**.
- Atmospheric pressure **decreases** with **altitude** from the **surface of the Earth.**

FRICTION

- Frictional force or friction arises when two or more bodies in contact move or tend to move, relative to each other. It acts always in the opposite direction of the moving body. This force is produced due to the geometrical dissimilarities of the surface of the bodies, which are in relative motion
- There are four types of friction: static, sliding, rolling, and fluid friction. Static, sliding, and rolling friction occur between solid surfaces. Fluid friction occurs in liquids and gases.
- The frictional force exerted by fluids is also called drag.
- Friction can be increased by increasing the area of the surfaces in contact
- Friction depends on the nature of surfaces in contact.
- Friction can produce the following effects.
  1. Friction opposes motion.

2. It causes wear and tear of the surfaces in contact.
3. It produces heat.

Increasing and Reducing Friction

- The substances which reduce friction are called lubricants.
- Friction can never be entirely eleminated. No surface is perfectly smooth. Some irregularities are always there.

Advantages of Friction

- We can hold objects in our hand due to friction.
- We can walk on the road because of friction. The friction between footwear and the ground help us to walk without slipping.
- Writing on the paper with a pen is easy due to friction.
- Automobiles can move safely due to friction between the tyres and the road. Brakes can be applied due to frictional resistance on brake shoes.

Spring Balance

- Spring balance is a device used for measuring the force acting on an object. It consists of a coiled spring which gets stretched when a force is applied to it. Stretching of the spring is measured by a pointer moving on a graduated scale. The reading on the scale gives the magnitude of the force

GRAVITATION

All objects in the universe attract each other. This force of attraction between objects is called the gravitational force. Gravitation is a weak force unless large masses are involved

Centripetal force

- The force that causes acceleration and keeps the body moving along the circular path is acting towards the Centre. This force is called the centripetal ('Centreseeking') force
- The motion of the moon around the earth is due to the centripetal force. If there were no such force the moon would pursue a uniform straight line motion.

Centrifugal force

- The force that is felt by an object moving in a curved path that acts outwardly away from the center of rotation
- Centrifugal force acts in a direction which is opposite to the direction of the centripetal force.
- Some of the applications of centrifugal force

1. Banking of roads.
2. Washing machine dryer.
3. Cream separator.

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.

$$F = G\frac{Mm}{d^2}$$

G→ Universal gravitation constant

G→6.673 *10–11 N m^2 kg^{-2}

- The value of G was found out by Henry Cavendish (1731 – 1810) by using a sensitive balance
- The force exerted by the earth on the moon is 2.02 *10^{20} N
- Newton's law of gravitation is called universal law of gravitation because it is applicable to all the bodies having mass whether the bodies are big or small or whether the bodies are terrestrial or celestial

Isaac Newton

- Isaac Newton was born in Woolsthorpe near Grantham, England. He is generally regarded as the most original and influential theorist in the history of science.
- Newton formulated the well-known laws of motion. He worked on theories of light and colour. He designed an astronomical telescope to carry out astronomical observations. Newton was also a great mathematician. He invented a new branch of mathematics, called calculus. He used it to prove that for objects outside a sphere of uniform density, the sphere behaves as if the whole of its mass is concentrated at its centre.
- Newton transformed the structure of physical science with his three laws of motion and the universal law of gravitation. As the keystone of the scientific revolution of the seventeenth century, Newton's work combined the contributions of Copernicus, Kepler, Galileo, and others into a new powerful synthesis.

IMPORTANCE OF THE UNIVERSAL LAW OF GRAVITATION

- The force that binds us to the earth.
- The motion of the moon around the earth.
- The motion of planets around the Sun.
- The tides due to the moon and the Sun.

Acceleration due to gravity

- Whenever an object falls towards the earth acceleration is involved. This acceleration is due to the earth's gravitational force. Therefore this acceleration is called the acceleration due to the gravitational force of the earth or acceleration due to gravity

  $g=GM/R^2$

  G = 6.7 × 10–11 N m2 kg-2,
  Mass of the earth M= 6×10^{24} kg
  Radius of the earth R= 6.4×10^{6} m.
  From the equation we get g value
- Value of acceleration due to gravity of the earth, $g = 9.8$ m/s^2
- The earth is not a perfect sphere. The radius of the earth increases from the poles to the equator because value of *g* becomes greater at the poles than at the equator.
- Value of g **decreases** with the increase of **height**
- Value of g **decreases** with depth and become **zero** at the center of the earth
- Acceleration experienced by an object is independent of its mass. It means that all objects hollow or solid, big or small, should fall at the same rate

Mass of the Earth

- Mass of the Earth $M = g R^2 /G$
  Substituting the known values of g, R and G, you can calculate the mass of the Earth as
  $M = 5.972 \times 10^{24}$ kg

MASS

- The **Mass** is a measure of the amount of matter in an object and it is a scalar quantity and its SI unit is kilograms
- It remains the same whether the object is on the earth the moon or even in outer space
- The **mass of an object is constant and does not change from place to place**

WEIGHT

- The earth attracts every object with a certain force and this force depends on the mass (*m*) of the object and the acceleration due to the gravity (*g*)
- The weight of an object is the force with which it is attracted towards the earth

  W=mg
- The SI unit of weight is the same as that of force that is newton (N) and weight is a vector quantity
- Weight depends on its location because *g* depends on location

- Acceleration due to gravity of the moon is less than the acceleration due to gravity of the earth because Weight of the object on the **moon1/6th of its weight on the earth**
- The **weight of an object is directly proportional to its mass**

  $W \propto m$

APPARENT WEIGHT

- The weight that you feel to possess during up and down motion is not same as your actual weight. Apparent weight is the weight of the body acquired due to the action of gravity and other external forces acting on the body.
- Different possibilities of the apparent weight of the person that arise, depending on the motion of the lift
  1. Lift is moving upward with acceleration → Apparent weight is greater than the actual weight.
  2. Lift is moving downward with acceleration → Apparent weight is lesser than the actual weight.
  3. Lift is at rest→Apparent weight is equal to the actual weight.
  4. Lift is falling down freely→ Apparent weight is equal to zero.

THRUST AND PRESSURE

- The force acting on an object perpendicular to the surface is called thrust.
- In SI units, the unit of thrust is newton (denoted as N)
- The force per unit area acting on an object concerned is called pressure. We can say thrust on a unit area is pressure.

  Pressure = Thrust /Area
- The unit of pressure is newton per square metre or newton metre^{-2} (denoted as Nm^{-2})
- 1 newton per square metre is called as 1 pascal

PRESSURE IN FLUIDS

- All liquids and gases are fluids.
- A solid exerts pressure on a surface due to its weight. Similarly, fluids have weight, and they also exert pressure on the base and walls of the container in which they are enclosed. Pressure exerted in any confined mass of fluid is transmitted undiminished in all directions.

Buoyancy

- Buoyancy is the force exerted on an object that is wholly or partly immersed in a fluid
- All objects experience a force of buoyancy when they are immersed in a fluid
- The magnitude of this buoyant force depends on the density of the fluid
- Salt water provides more buoyant force than fresh water, because, buoyant force depends as much on the density of fluids as on the volume displaced.

Archimedes' Principle

- Archimedes principle states that '**a body immersed in a fluid experiences a vertical upward buoyant force equal to the weight of the fluid it displaces'**
- Archimedes principle has many applications
  - It is used in designing **ships and submarines**
  - **Lactometers** which are used to determine the **purity of a sample of milk**
  - **Hydrometers** used for determining **density of liquids**

Archimedes

- Archimedes was a Greek scientist. He discovered the principle, subsequently named after him, after noticing that the water in a bathtub overflowed when he stepped into it. He ran through the streets shouting "Eureka!", which means "I have got it". This knowledge helped him to determine the purity of the gold in the crown made for the king.
- His work in the field of Geometry and Mechanics made him famous. His understanding of levers, pulleys, wheels and-axle helped the Greek army in its war with Roman army.

Relative Density

- The density of a substance is defined as mass of a unit volume. The unit of density is kilogram per metre cube
- The density of a given sample of a substance can help us to determine its purity.
- Objects having density less than that of the liquid in which they are immersed float on the surface of the liquid
- Density of the object is more than the density of the liquid in which it is immersed then it sinks in the liquid
- The relative density of a substance is the ratio of its density to that of water

  Relative density=Density of a substance/Density of water

  Since the relative density is a ratio of similar quantities, it has no unit.

Pascal's law

- Pascal's law states that an increase in pressure at any point inside a liquid at rest is transmitted equally and without any change, in all directions to every other point in the liquid.

The applications of Pascal's law are:

- In automobile service stations, the vehicles are lifted upward using the hydraulic lift which works as per Pascal's law.
- Automobile brake system works according to Pascal's law.
- The hydraulic press is used to compress the bundles of cotton or cloth so as to occupy less space.

Surface Tension

- Surface tension is the property of a liquid. The molecules of a liquid experience a force, which contracts the extent of their surface area as much as possible, so as to have the minimum value. The amount of force acting per unit length, on the surface of a liquid is defined as surface tension.
- Its unit is Nm–1.
- Surface tension is the reason for many events we see in our daily life.
  1. In plants, water molecules rise up due to surface tension. **Xylem tissues** are very narrow vessels present in plants. Water molecules are absorbed by the roots and these vessels help the water to rise upward due to 'capillarity action', which is caused by the surface tension of water.
  2. During heavy storm, ships are damaged due surface tension of water. By pouring oil or soap powder into **the sea, sailors reduce its impact**.
  3. Water strider **insect** slides on the water surface easily due to the surface tension of **water**
  4. A **falling drop of rain** water acquires the spherical shape due to **Surface Tension**

Viscosity

- The **frictional force acting** between the successive layers of the **liquid** which acts in order to oppose the relative motion of the layer is known as viscous force. Such a property of a liquid is called **viscosity**.

WORK AND ENERGY

WORK

- We define work to be equal to the product of the force and displacement
  Work done = force * displacement
- Work done by force acting on an object is equal to the magnitude of the force multiplied by the distance moved in the direction of the force. Work has only magnitude and no direction
- Unit of work is newton metre (N m) or joule (J)
- Work done on an object by a force would be zero if the displacement of the object is zero
- The work done by a force can be either positive or negative
- Work done is **negative** when the force acts **opposite** to the direction of displacement.
- Work done is **positive** when the force is in the **direction of displacement**
- When a body falls freely **under gravity** then the work done by the gravity is **positive**
  Explanation is
  If a force acting on a body has a component in the direction of displacement then the work done by the force is positive because when a body falls freely under the influence of gravity the work done by the gravity is positive

- When a body slides against a rough horizontal surface the work done by friction is **negative**
  Explanation is
  When a body slides against a rough horizontal surface its displacement is opposite to that of the force of friction so the works done by the friction is negative

ENERGY

- Life is impossible without energy
- An object having capability to do work is said to possess energy
- Unit of **energy** is **joule**. **Joule** is also unit of **work**
- Various form of energy are Mechanical energy, Electrical energy, Atomic energy, Heat energy, Light energy, Chemical energy and sound energy.
- Energy of one form can be transformed into energy of another form
- The **sum of the kinetic and potential energies** of an object is called its **mechanical energy**

James Prescott Joule

- James Prescott Joule was an outstanding British physicist. He is best known for his research in electricity and thermodynamics. Amongst other things, he formulated a law for the heating effect of electric current. He also verified experimentally the law of conservation of energy and discovered the value of the mechanical equivalent of heat. The unit of energy and work called joule, is named after him.

KINETIC ENERGY

- Kinetic energy is the energy possessed by an object due to its motion
- The **kinetic energy** of an object **increases with its Speed**
- **Example of kinetic energy** are Falling coconut, a speeding car, a rolling stone, a flying aircraft, flowing water, blowing wind, a running athlete etc.
- The kinetic energy of a body moving with a certain velocity is equal to the work done on it to make it acquire that velocity
- An object of mass (m) moving with velocity (v) has a kinetic energy of

$$\frac{1}{2}mv^2$$

POTENTIAL ENERGY

- The energy possessed by a body due to **its change in position or shape** is called the **potential energy**
- The potential energy possessed by the object is the energy present in it by virtue of its position or configuration
- An object increases its energy when raised through a height. This is because work is done on it against gravity while it is being raised. The energy present in such an object is the gravitational potential energy.
- The gravitational potential energy of an object at a point above the ground is defined as the work done in raising it from the ground to that point against gravity
- The gravitational potential energy of an object of mass (m) raised through a height (h) from the earth's surface is given **by = m g h.**
- The work done by gravity depends on the difference in vertical heights of the initial and final positions of the object and not on the path along which the object is moved

LAW OF CONSERVATION OF ENERGY

According to the law of conservation of energy

- The energy can neither be **created nor destroyed**.
- Energy can only be **transformed** from one form to another.
- The **total energy** before and after the transformation always remains **constant**
- An object of mass (m) is made to fall freely from a height (h). At the start, the potential energy is mgh and kinetic energy is zero. Why is the kinetic energy zero. It is zero because its velocity is zero. The total energy of the object is thus mgh. As it falls its potential energy will change into kinetic energy. If *v* is the velocity of the object at a given instant the kinetic energy would be ½mv^2. As the fall of the object continues, the potential energy would decrease while the kinetic energy would increase. When the object is about to reach the ground, *h* = 0 and *v* will be the highest. Therefore, the kinetic energy would be the largest and potential energy the least. However, the sum of the potential energy and kinetic energy of the object would be the same at all points

  Potential energy + kinetic energy = constant
- The sum of kinetic energy and potential energy of an object is its total mechanical energy

Rate of Doing Work

- Power is defined as the rate of doing work or the rate of transfer of energy

  Power = work/time
- Unit of power is watt
- 1 watt = 1 joule/second or 1 W = 1 J s^{-1}
- The unit joule is too small and hence is inconvenient to express large quantities of energy. We use a bigger unit of energy called kilowatt hour
- 1 kW h = 3.6 * 10^6 J

- The energy used in households, industries and commercial establishments are usually expressed in kilowatt hour.

SOUND

- Sound is a form of energy which produces a sensation of hearing in our ears. There are also other forms of energy like mechanical energy, light energy, etc.
- Sound is produced due to vibration of different objects
- Sound waves are **longitudinal mechanical** waves
- Sound waves are characterized by the motion of particles in the medium and are called mechanical waves.
- The **sound of the human voice** is produced due to vibrations in the **vocal cords**.

The vocal cords in men are about **20 mm long**. In women these are about **15mm long**. Children have very short vocal cords. This is the reason why the voices of men, women and children are different.

- The eardrum senses the vibrations of sound it sends the signals to the brain. This process is called hearing.
- The eardrum is like a stretched rubber sheet.
- The **outer ear** is called **pinna** Its collects the sound from the **surroundings**
- The matter or substance through which sound is transmitted is called a **medium**. It can be solid, liquid or gas.

SOUND NEEDS A MEDIUM TO TRAVEL

- Sound is a mechanical wave and needs a material medium like air, water, steel etc.
- Sound **cannot travel through vacuum**

CHARACTERISTICS OF A SOUND WAVE

Sound wave describe its

- Frequency
- Amplitude
- Speed

FREQUENCY

- The distance between two consecutive compressions or two consecutive rarefactions is called the wavelength. Its SI unit is metre.
- The number of such oscillations per unit time is the frequency of the sound wave.SI unit is hertz

- Human ear can hear sound of frequency from **20 Hz to 20,000 Hz.** Sound with frequency **less than 20 Hz is called infrasonic sound**. Sound with frequency **greater than 20,000 Hz is called ultrasonic sound**. Human beings cannot hear infrasonic and ultrasonic sounds.
- Time taken by two consecutive compressions or rarefactions to cross a fixed point is called the time period of the wave.SI unit is second.
- Frequency and time period are reciprocal to each other.
- Relationship between frequency and time period is.

$$\nu = \frac{1}{T}.$$

- The sensation of frequency commonly referred as the pitch of a sound. Objects of different sizes and conditions vibrate at different frequencies to produce sounds of different pitch.
- The frequency determines the shrillness or pitch of a sound. If the frequency of vibration is higher we say that the sound is shrill and has a higher pitch. If the frequency of vibration is lower, we say that the sound has a lower pitch.
- A **sound of single frequency** is called a **tone**.
- When sound waves move from one medium to another medium its **wavelength and speed changes** but **frequency remains unchanged.**

Heinrich Rudolph Hertz

- Heinrich Rudolph Hertz was born on 22 February 1857 in Hamburg, Germany and educated at the University of Berlin. He confirmed J.C. Maxwell's electromagnetic theory by his experiments. He laid the foundation for future development of radio, telephone, telegraph and even television. He also discovered the photoelectric effect which was later explained by Albert Einstein. The SI unit of frequency was named as hertz in his honour.

AMPLITUDE

- Magnitude of the maximum disturbance in the medium on either side of the mean value is called the amplitude of the wave.
- The loudness or softness of a sound is determined basically by its amplitude. If the vibration of a particle has large amplitude, the sound will be loud and if the vibration has small amplitude, the sound will be soft
- The amplitude of the sound wave depends upon the force with which an object is made to vibrate. If we strike a table lightly, we hear a soft sound because we produce a sound wave of less energy (amplitude).
- Sound wave source moves away from the source its amplitude as well as its loudness decreases. Louder sound can travel a larger distance as it is associated with higher energy

- Loudness of sound is proportional to the square of the amplitude of the vibration producing the sound. For example, if the amplitude becomes twice, the loudness increases by a factor of 4. The loudness is expressed in a unit called decibel (dB).

SPEED

- Speed of sound is defined as the distance which a point on a wave such as a compression or a rarefaction travels per unit time

  Speed=distance/time
- The speed of sound remains almost the same for all frequencies in a given medium under the same physical conditions
- Amount of sound energy passing each second through unit area is called the intensity of sound
- The speed of sound decreases when we go from solid to gaseous state. Speed of the sound **maximum in solid** state and **minimum in gaseous state**.
- The **speed of the sound remains unchanged** by the increase or decrease of **pressure**.
- The speed of sound in a medium depends on temperature of the medium. In any medium as we increase the temperature the speed of sound increases
- **Speed of sound** is more in **humid air than dry air** because density of humid air is less than dry air
- The speed of sound depends on the properties of the medium through which it travels
- The sound of thunder is heard a little later than the flash of light is seen. So, we can make out that sound travels with a speed which is much less than the speed of light.
- Sound travels about 5 times faster in water than in air. Since the speed of sound in sea water is very large.
- **Speed of sound in different medium**

Substance	**Speed m/s**
Aluminium	6420
Nickel	6040
Steel	5960
Iron	5950
Brass	4700
Glass	3980
Water(sea)	1531
Water(distilled)	1498
Ethanol	1207
Methanol	1103

Hydrogen	1284
Helium	965
Air	346
Oxygen	316
Sulphur dioxide	213

SONIC BOOM

- When the **speed of any object exceeds the speed of sound** it is said to be travelling at **supersonic speed**. Bullets, jet aircrafts etc. often travel at supersonic speeds. When a sound, producing source moves with a speed higher than that of sound, it produces shock waves in air. These shock waves carry a large amount of energy. The air pressure variation associated with this type of shock waves produces a very sharp and loud sound called the "sonic boom". The shock waves produced by a supersonic aircraft have enough energy to shatter window glass and even damage buildings.

REFLECTION OF SOUND

- Sound bounces off a surface of solid or a liquid medium like a rubber ball that bounces off from a wall.
- An obstacle of large size which may be polished or rough is needed for the reflection of sound waves.
- The laws of reflection are:
    1. The angle in which the sound is incident is equal to the angle in which it is reflected.
    2. Direction of incident sound, the reflected sound and the normal are in the same plane.

ECHO

- We will hear the same sound again a little later due to the reflection of sound wave is called echo
- To hear a distinct echo the time interval between the original sound and the reflected one must be at **least 0.1s**
- The total distance covered by the sound from the point of generation to the reflecting surface and back should be at least 340 ms–1 × 0.1 s = **34 m**. Thus, for hearing distinct echoes, the minimum distance of the obstacle from the source of sound must be half of this distance i.e. **17 m**. This distance will change with the temperature of air. Echoes may be heard more than once due to successive or multiple reflections

REVERBERATION

- The repeated reflection that results in this persistence of sound is called reverberation
- A sound created in a big hall will persist by repeated reflection from the walls until it is reduced to a value where it is no longer audible. The repeated reflection that results in this persistence of sound is called reverberation.

USES OF MULTIPLE REFLECTION OF SOUND

- Megaphones or loudhailers, horns, musical instruments such as trumpets and shehanais are all designed to send sound in a particular direction without spreading it in all directions
- Stethoscope is a medical instrument used for listening to sounds produced within the body, mainly in the heart or lungs.
- The ceilings of concert halls conference halls and cinema halls are curved so that sound after reflection reaches all corners of the hall

RANGE OF HEARING

- The audible range of hearing for average human beings is in the frequency range of 20 Hz – 20 kHz
- Sounds of frequencies below 20 Hz are called infrasonic sound or infrasound
- Frequencies higher than 20 kHz are called ultrasonic sound or ultrasound

INFRASONIC SOUND

- Sounds of frequencies below 20 Hz are called infrasonic sound or infrasound
- Rhinoceroses communicate using infrasound of frequency as low as 5 Hz
- Whales and elephants produce sound in the infrasound range
- Earthquakes produce low-frequency infrasound before the main shock waves begin which possibly alert the animals

ULTRASONIC SOUND

- Ultrasonic sound is the term used for sound waves with frequencies greater than 20,000Hz. These waves cannot be heard by the human ear, but the audible frequency range for other animals includes ultrasound frequencies. For example, dogs can hear ultrasonic sound.

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APPLICATIONS OF ULTRASOUND

- Ultrasounds can be used to detect cracks and flaws in metal blocks
- Ultrasonic waves are made to reflect from various parts of the heart and form the image of the heart. This technique is called echocardiography.
- Ultrasound scanner is an instrument which uses ultrasonic waves for getting images of internal organs of the human body.
- Ultrasound may be employed to break small stones formed in the kidneys into fine grains
- Ultrasounds can be used in cleaning technology. Minute foreign particles can be removed from objects placed in a liquid bath through which ultrasound is passed.
- Porpoises use ultrasound for navigation and location of food in the dark

SONAR

- SONAR stands for Sound Navigation And Ranging
- Sonar is a device that uses ultrasonic waves **to measure the distance ,direction and speed of underwater objects**
- Sonar consists of a transmitter and a detector and is installed at the bottom of boats and ships.
- The transmitter produces and transmits ultrasonic waves. These waves travel through water and after striking the object on the seabed, get reflected back and are sensed by the detector. The detector converts the ultrasonic waves into electrical signals which are appropriately interpreted. The distance of the object that reflected the sound wave can be calculated by knowing the speed of sound in water and the time interval between transmission and reception of the ultrasound

STRUCTURE OF HUMAN EAR

- The outer ear is called '**pinna'**. It collects the sound from the surroundings. The collected sound passes through the auditory canal.
- At the end of the ear is eardrum or tympanic membrane. When a compression of the medium reaches the eardrum the pressure on the outside of the membrane increases and forces the eardrum inward. Similarly, the eardrum moves outward when a rarefaction reaches it. In this way the eardrum vibrates. The vibrations are amplified several times by three bones (the hammer, anvil and stirrup) in the middle ear.
- The middle ear transmits the amplified pressure variations received from the sound wave to the inner ear.
- In the inner ear, the pressure variations are turned into electrical signals by the cochlea. These electrical signals are sent to the brain via the auditory nerve and the brain interrupts them as sound.

Noise Pollution

- Unpleasant sounds are called noise.
- Excessive or unwanted sounds lead to noise pollution. Noise pollution may pose health problems for human beings.
- Lack of sleep, hypertension (high blood pressure), anxiety and many more health disorders may be caused by noise pollution.
- Major causes of noise pollution are sounds of vehicles, explosions including bursting of crackers, machines, loudspeakers etc.
- Plantation on the roadside and elsewhere can reduce noise pollution.

LIGHT

LIGHT-REFLECTION AND REFRACTION

- Light is a radiation which makes our eyes able to see the object when light from an object enters our eyes that we see the object. The light may have been emitted by the object, or may have been reflected by it
- Light wave is an **electromagnetic wave**. It has an electric and a magnetic component
- Light is a **transverse wave**
- Light seems to travel in straight lines
- **Opaque objects** do **not allow light** to pass through them
- **Transparent objects** allow light to pass through them and we can see through these objects clearly
- **Translucent objects** allow light to pass through them **partially**

> The materials through which objects can be seen, but not clearly, are known as translucent.
> Substances or materials, through which things can be seen, are called transparent. Glass, water, air and some plastics are examples of transparent materials.

- **Shadows** are **formed** when an **opaque object** comes in the path of light
- Light travels in vacuum with an enormous speed of 3×10^8 m s-1. The speed of light is different in different media
- Sun light is **white colour**
- Sunlight takes an **average of 8 minutes and 20 seconds** to travel from the **Sun to the Earth**
- White light is composed of **seven colours.**
- Splitting of light into its constituent colours is known as **dispersion**
- Light is reflected from all surfaces
- Any polished or a shining surface acts as a mirror
- An image which can be obtained on a screen is called a **real image**
- An image which cannot be obtained on a screen is called a **virtual image**
- The image formed by a **plane mirror is erect**. It is virtual and is of the same size as the object. The image is at the same distance behind the mirror as the object is in front of it
- In an image formed by a mirror, the left side of the object is seen on the right side in the image, and right side of the object appears to be on the left side in the image
- Visually impaired persons can read and write using the **Braille system**
- Beautiful patterns are formed in a kaleidoscope because of **multiple reflections**
- **Periscope** works on the **Laws of Reflection.** Periscopes are used in submarines, tanks and also by soldiers in bunkers to see things outside

REFLECTION

- A highly polished surface such as a mirror reflects most of the light falling on it.

- Mirror changes the direction of light that falls on it. This change of direction by a mirror is called reflection of light.
- Any polished or a shiny surface can act as a mirror.
- Example a shining stainless steel plate or a shining steel spoon can change the direction of light. The surface of water can also act like a mirror and change the path of light.
- Image formed by a **plane mirror** is always **virtual and erect**
- The size of the image is equal to that of the object
- **Want to see full image** in a **plane mirror** a person required a mirror of at least half the object

- Lateral inversion is a phenomenon of the mirror in which the left of the object appears on the right and the right appears on the left.
- Image formed in a plane mirror undergoes lateral inversion.

LAWS OF REFLECTION

- After striking the mirror the ray of light is reflected in another direction. The light ray which strikes any surface is called the incident ray
- The ray that comes back from the surface after reflection is known as the reflected ray
- **Two laws of reflection are**
  1. The angle of incidence is equal to the angle of reflection.
  2. Incident ray, reflected ray and the normal drawn at the point of incidence to the reflecting surface, lie in the same plane
- These laws of reflection are applicable to all types of reflecting surfaces including spherical surfaces

Nearly everything we see around is seen due to reflected light. Moon, for example, receives light from the Sun and reflects it. That's how we see the moon. The objects which shine in the light of other objects are called illuminated objects.
There are other objects, which give their own light, such as the Sun, fire, flame of a candle and an electric lamp. Their light falls on our eyes. That is how we see them. The objects which emit their own light are known as luminous objects.

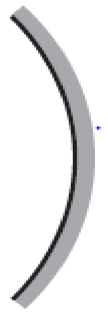
OPTICAL DENSITY

- The ability of a medium to refract light is also expressed in terms of its optical density. Optical density has a definite connotation. It is not the same as mass density.
- Denser medium means optically denser medium and rarer medium means optically rarer medium.
- In comparing two media, the one with the larger refractive index is optically denser medium than the other. The other medium of lower refractive index is optically rarer. The speed of light is higher in a rarer medium

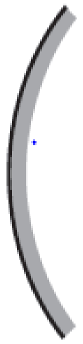
than a denser medium. Thus, a ray of light travelling from a rarer medium to a denser medium slows down and bends towards the normal. When it travels from a denser medium to a rarer medium, it speeds up and bends away from the normal.

SPHERICAL MIRROR

- The reflecting surface of a spherical mirror may be curved inwards or outwards
- A spherical mirror whose reflecting surface is **curved inwards** that is faces towards the center of the sphere is called a **concave mirror**
- A spherical mirror whose reflecting surface is curved **outwards** is called a **convex mirror**



CONCAVE MIRROR



CONVEX MIRROR

- Distance between the pole and the principal focus of a spherical mirror is called the focal length
- Radius of curvature is found to be equal to twice the focal length
- The centre of the reflecting surface of a spherical mirror is a point called the pole.

IMAGE FORMATION BY A CONCAVE MIRROR FOR DIFFERENT POSITIONS OF THE OBJECT

Position of the object	Position of the image	Size of the image	Nature of the image
At infinity	At the focus	Highly diminished	Real and inverted
Beyond center of curvature	Between focus and center of curvature	Diminished	Real and inverted
At center of curvature	At center of curvature	Same size	Real and inverted
Between center of curvature and focus	Beyond center of curvature	Enlarged	Real and inverted
At focus	At infinity	Highly enlarged	Real and inverted
Between pole and Focus	Behind the mirror	Enlarged	Virtual and erect

NATURE POSITION AND RELATIVE SIZE OF THE IMAGE FORMED BY A CONVEX MIRROR

Position of the object	Position of the image	Size of the image	Nature of the image
At infinity	At the focus Focus behind the mirror	Highly diminished	Virtual and erect
Between infinity and the pole of the mirror	Between pole and Focus behind the mirror	Diminished	Virtual and erect

USES OF CONCAVE MIRRORS

- Concave mirrors are used in torches, search-lights and vehicles headlights to get powerful parallel beams of light.
- Used as a shaving mirrors to see a larger image of the face.
- Dentists use concave mirrors to see large images of the teeth of patients.
- Concave mirrors are used to concentrate sunlight to produce heat in solar furnaces

USES OF CONVEX MIRRORS

- Convex mirrors are commonly used as rear view mirrors in vehicles

- Convex mirrors are installed on public roads as traffic safety device. They are used in acute bends of narrow roads such as hairpin bends in mountain passes where direct view of oncoming vehicles is restricted

MIRROR FORMULA

The relationship between the object-distance (*u*), image-distance (*v*), and focal length (*f*) of a spherical mirror given by the mirror formula which is expressed as

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

MAGNIFICATION

Magnification is expressed as the ratio of the height of the image to the height of the Object

$$m = \frac{\text{Height of the image } (h')}{\text{Height of the object } (h)}$$

REFRACTION OF LIGHT

- Refraction of light is the change in direction of a light ray when it travels from one medium to another
- This deviation (change in direction) in the path of light is due to the change in velocity of light in the different medium
- Velocity of light is more in a rarer medium (low optical density) than in a denser medium (high optical density).
- Light does not travel in the same direction in all media. It appears that when travelling obliquely from one medium to another, the direction of propagation of light in the second medium changes. This phenomenon is known as refraction of light
- The coin becomes visible on pouring water into the bowl. The coin appears slightly raised above its actual position due to refraction of light.
- Lemon kept in water in a glass tumbler appears to be bigger than its actual size, when viewed from the sides **due to refraction of light**
- When a ray of light enter one medium to another medium its **phase and frequency do not change** but **wavelength and velocity change**

LAWS OF REFRACTION OF LIGHT

- Following are the laws of refraction of light.

- The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
- The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction.
  (This is true for angle 0 <*i* < 90o)

If I is the angle of incidence and r is the angle of refraction

$$\frac{\sin i}{\sin r} = constant$$

REFRACTIVE INDEX

- Refraction of light in a medium depends on the speed of light in that medium. When the speed of light in a medium is more, the bending is less and when the speed of light is less, the bending is more.
- The refractive index of a transparent medium is the ratio of the speed of light in vacuum to that in the medium
  Refractive index= Speed of light in medium 1/Speed of light in medium 2
- Refractive indices of some common substances are

Substances	Refractive index
Air	1.0003
Ice	1.31
Water	1.33
Alcohol	1.36
Kerosene	1.44
Rock salt	1.54
Diamond	2.42

LENS FORMULA

- Lens formula gives the relationship between object distance (*u*), image-distance (*v*) and the focal length (*f*). The lens formula is

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

MAGNIFICATION

The magnification is defined as the ratio of the height of the image and the height of the object

$$m = \frac{\text{Height of the image } (h')}{\text{Height of the object } (h)}$$

POWER OF LENS

- The degree of convergence or divergence of light rays achieved by a lens is expressed in terms of its power
- Power of a lens is defined as the reciprocal of its focal length

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

- SI unit of power of a lens is **dioptre**

TOTAL INTERNAL REFLECTION

- When the angle of incidence exceeds the value of critical angle the refracted ray is impossible. Since r > 90º refraction is impossible and the ray is totally reflected back to the same medium (denser medium). This is called as total internal reflection.
- Conditions to achieve total internal reflection
  1. Light must travel from denser medium to rarer medium. (Example: From water to air). „
  2. The angle of incidence inside the denser medium must be greater than that of the critical angle.

Examples of Total Internal Reflection

- **Optical fibres** work on the phenomenon of **total internal reflection**
- Mirage
- Total internal reflection is the main cause for the spectacular brilliance of **diamonds**

Braille System

- The most popular resource for visually challenged persons is Braille.
- Louis Braille, himself a visually challenged person, developed a system for visually challenged persons and published it in 1821.

- The present system was adopted in 1932. There is Braille code for common languages, mathematics and scientific notation. Many Indian languages can be read using the Braille system.
- Braille system has 63 dot patterns or characters. Each character represents a letter, a combination of letters, a common word or a grammatical sign. Dots are arranged in cells of two vertical rows of three dots each.
- Lal Advani, himself visually impaired, established an Association for special education and rehabilitation of disabled in India. Besides this, he represented India on Braille problems in UNESCO.
- Helen A. Keller, an American author and lecturer, is perhaps the most wellknown and inspiring visually challenged person. She lost her sight when she was only 18 months old. But because of her resolve and courage she could complete her graduation from a university. She wrote a number of books including The Story of my Life (1903).

THE HUMAN EYE AND THE COLOURFUL WORLD

- Human eye is one of the most valuable and sensitive sense organs
- Light enters the eye through a thin membrane called the **cornea**
- **Retina** is lens system forms an image on a **light-sensitive screen**
- The human eye forms the image of an object at its **retina**
    - The retina contains several nerve cells. Sensations felt by the nerve cells are then transmitted to the brain through the optic nerve. There are two kinds of cells–
      (i) cones, which are sensitive to bright light and
      (ii) rods, which are sensitive to dim light.
      Cones sense colour. At the junction of the optic nerve and the retina, there are no sensory cells, so no vision is possible at that spot. This is called the blind spot.
    - The impression of an image does not vanish immediately from the retina. It persists there for about 1/16th of a second. So, if still images of a moving object are flashed on the eye at a rate faster than 16 per second, then the eye perceives this object as moving.

- **Iris** is colored part of the eye. It may be blue, brown or green in colour. Every person has a unique colour, pattern and texture. It holds the pupil and also adjust the size of pupil according to the intensity of light
- **Pupil** is black in color and absorbs all the light rays falling on it. It gets constricted when the intensity of light is high. It gets expanded when the intensity of light is low
- **Pupil** is the centre part of the Iris. It is the **pathway for the light** to retina.
- **Ciliary muscles** hold the lens. They adjust the **focal length** of the lens
- **Eye Lens** is the important part of human eye. It is **convex in nature**.

- The ability of the eye to focus on both near and distant objects by adjusting its focal length is called the accommodation of the eye
- The eye lens forms an **inverted real image** of the object on the retina. The retina is a delicate membrane having enormous number of light-sensitive cells. The light-sensitive cells get activated upon illumination and generate electrical signals. These signals are sent to the brain via the optic nerves. The smallest distance at which the eye can see objects clearly without strain is called the near point of the eye or the least distance of distinct vision. For a young adult with **normal vision it is about 25 cm**.
- The farthest point up to which the eye can see objects clearly is called the **far point** of the eye. It is **infinity** for a normal eye
- The crystalline lens of people at old age becomes milky and cloudy. This condition is called cataract. This causes partial or complete loss of vision. It is possible to restore vision through a cataract surgery.

Two eyes for vision

- There are several advantages of our having two eyes instead of one. It gives a wider field of view. A human being has a horizontal field of view of about 150° with one eye and of about 180° with two eyes. The ability to detect faint objects is, of course, enhanced with two detectors instead of one.

DEFECTS OF VISION AND THEIR CORRECTION

- A normal human eye can clearly see all the objects placed between 25cm and infinity. But, for some people, the eye loses its power of accommodation. This could happen due to many reasons including ageing. Hence, their vision becomes defective. Let us discuss some of the common defects of human eye.
- There are mainly three common refractive defects of vision
    - Myopia or near-sightedness
    - Hypermetropia or farsightedness,
    - Presbyopia

MYOPIA

- Myopia is also known as **near-sightedness**
- A person with myopia can see nearby objects clearly but **cannot see distant objects distinctly.**
- The focal length of eye lens is reduced or the distance between eye lens and retina increases.
- In a **myopic eye the image** of a distant object is **formed in front of the retina**
- A **concave lens** of suitable power will bring the image back on to the retina and thus the defect is corrected

HYPERMETROPIA

- Hypermetropia is also known as **far-sightedness**
- A person with hypermetropia can see distant objects clearly but cannot see nearby objects distinctly

- The focal length of eye lens is increased or the distance between eye lens and retina decreases. Hence, the near point will not be at 25cm for such eyes and the near point has moved farther. Due to this, the image of nearby objects are formed behind the retina
- In a hypermetropia eye the image of a closeby object are focused at a **point behind the retina**
- This defect can be corrected by using a **convex lens** of appropriate power

PRESBYOPIA

- The power of accommodation of the eye usually decreases with ageing
- It arises due to the gradual **weakening of the ciliary muscles and diminishing** flexibility of the eye lens
- This defect can be corrected by using a **bi-focal lenses**
- A common type of **bi-focal lenses** consists of both **concave and convex lenses**. The upper portion consists of a concave lens .It facilitates distant vision. The lower part is a convex lens. It facilitates near vision.

ASTIGMATISM

- In this defect, eye cannot see parallel and horizontal lines clearly. It may be inherited or acquired. It is due to the imperfect structure of eye lens because of the development of cataract on the lens, ulceration of cornea, injury to the refracting surfaces, etc. Astigmatism can be corrected by using cylindrical lenses.

- Animals have eyes shaped in different ways. Eyes of a crab are quite small but they enable the crab to look all around. So, the crab can sense even if the enemy approaches from behind. Butterflies have large eyes that seem to be made up of thousands of little eyes. They can see not only in the front and the sides but the back as well.
- A night bird (owl) can see very well in the night but not during the day. On the other hand, day light birds (kite, eagle) can see well during the day but not in the night. The owl has a large cornea and a large pupil to allow more light in its eye. Also, it has on its retina a large number of rods and only a few cones. The day birds on the other hand, have more cones and fewer rods.

DISPERSION OF WHITE LIGHT BY A GLASS PRISM

- The angle between its two lateral faces is called the angle of the prism
- The prism has probably split the incident white light into a band of colours
- The various colours seen are Violet, Indigo, Blue, Green, Yellow, Orange and Red
- The **band of the coloured components** of a light beam is called its **spectrum**
- The **splitting of light** into its component colours is called **dispersion**

- Isaac Newton was the first to use a glass prism to obtain the spectrum of sunlight.
- Different colours of light bend through different angles with respect to the incident ray, as they pass through a prism. The **red light bends the least** while the **violet the most**
- **Red light has the longest wavelength** because red **refract least**, while **violet has the shortest** because **violet refract most**
- A **rainbow is scattering of light** a natural spectrum appearing in the **sky after a rain shower** .It is caused by **dispersion of sunlight by tiny water droplets**, present in the atmosphere .A **rainbow is always formed** in a direction **opposite to that of the Sun**. The **water droplets** act like **small prisms**. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop. Due to the dispersion of light and internal reflection, different colours reach the observer's eye

ATMOSPHERIC REFRACTION

- The **twinkling of a star** is due to atmospheric **refraction** of starlight
- The starlight on entering the earth's atmosphere undergoes refraction continuously before it reaches the earth. The atmospheric refraction occurs in a medium of gradually changing refractive index
- The Sun is visible to us about 2 minutes before the actual sunrise and about 2 minutes after the actual sunset because of **atmospheric refraction**. The apparent flattening of the Sun's disc at sunrise and sunset is also due to the same phenomenon

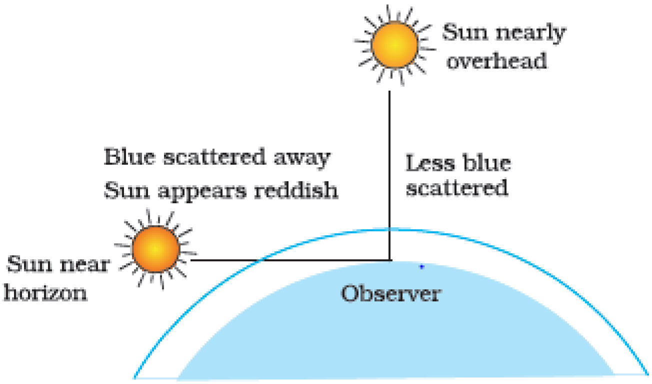
SCATTERING OF LIGHT

- When a beam of light interacts with a particle of matter it is redirected in many different directions. This phenomenon is called scattering of light.
- Scattering of light causes the blue colour of sky and the reddening of the Sun at sunrise and sunset

WHY THE COLOUR OF SKY IS BLUE

- Molecules of air and other fine particles in the atmosphere have size smaller than the wavelength of visible light
- The red light has a wavelength greater than blue light. When sunlight passes through the atmosphere the fine particles in air scatter the blue colour (shorter wavelengths) more strongly than red. The scattered blue light enters our eyes.
- If the earth had no atmosphere, there would not have been any scattering. Then, the **sky would have looked dark**. The sky appears dark to passengers flying at very high altitudes, as scattering is not prominent at such heights.
- The red is least scattered by fog or smoke that is the reason danger signal lights are red in colour

- At noon the Sun appears white as only a little of the blue and violet colours are scattered. Near the horizon most of the blue light and shorter wavelengths are scattered away by the particles. Therefore the light that reaches our eyes is of longer wavelengths. This gives rise to the reddish appearance of the Sun



ELECTRICITY

ELECTRIC CURRENT

- Electric current is expressed by the amount of charge flowing through a particular area in unit time.

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

- A continuous and closed path of an electric current is called an electric circuit.
- In electric circuit the direction of electric current is taken as opposite to the direction of the flow of electrons.
- SI unit of electric charge is coulomb
- Coulomb is equivalent to the charge contained in approximately 6 × 10^18 electrons
- Unit of electric current is ampere
- An instrument called ammeter measures electric current in a circuit. It is always connected in series in a circuit through which the current is to be measured.
- Materials that allow electric current to pass through them are called conductors.
- Materials that do not allow electric current to pass through them are called insulators.

POTENTIAL DIFFERENCE

- Electric potential difference between two points in an electric circuit carrying some current as the work done to move a unit charge from one point to the other
- SI unit of electric potential difference is volt
- Potential difference is measured by means of an instrument called the voltmeter
- Voltmeter is always connected in parallel across the points between which the potential difference is to be measured

OHM'S LAW

- The potential difference across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it provided its temperature remains the same. This is called Ohm's law

$$V=IR$$

- Its SI unit is ohm

RESISTANCE

- Resistance is the property of a substance to oppose to the flow of electric current through it, is called resistance
- The current through a resistor is inversely proportional to its resistance
- Rheostat is used to change the resistance in the circuit
- Motion of electrons through a conductor is opposed by its resistance. Component of a given size that offers a low resistance is a good conductor.
- A component of identical size that offers a higher resistance is a poor conductor
- **Insulator** have a **higher resistance**
- Resistance of the conductor depends on its length, on its area of cross-section, and on the nature of its material. Resistance of a uniform metallic conductor is directly proportional to its length (l) and inversely proportional to the area of cross-section (A)

$$R = \rho \frac{l}{A}$$

- The **resistance and resistivity** of a material vary with **temperature**
- The metals and alloys have very low resistivity in the range of 10^–8 ohm to 10^–6 ohm They are good conductors of electricity
- **Resistivity of an alloy** is generally higher than that of its constituent metals
- Tungsten is used almost exclusively for filaments of electric bulbs
- **Copper and Aluminium** are used in **electrical transmission lines**
- Silver is good conductor of electricity

RESISTORS IN SERIES

- The equivalent resistance of several resistors in series is equal to the sum of their individual resistances
- The same current flows through all the loads.
- The voltage across each load is proportional to the resistance of the load.
- The sum of the voltages across each load is equal to the applied voltage
- If resistors in series

$$I = I_1 = I_2 = \dots$$
$$V = V_1 + V_2 + \dots$$
$$R = R_1 + R_2 + \dots$$

- A series circuit connects the components one after the other to form a 'single loop'. A series circuit has only one loop through which current can pass. If the circuit is interrupted at any point in the loop, no current can pass through the circuit and hence no electric appliances connected in the circuit will work. **Series circuits** are commonly used in **devices such as flashlights.**

RESISTORS IN PARALLEL

- The reciprocal of the equivalent resistance of a group of resistances joined in parallel is equal to the sum of the reciprocals of the individual resistances.
- The current flowing through each load depends upon the resistance of the load.
- The voltage across each load is the same and is equal to the voltage applied to the circuit.
- The total resistance of a parallel connection is always smaller than the smallest resistance in the circuit.
- If resistors in parallel

$$I = I_1 + I_2 + \dots$$
$$V = V_1 = V_2 \dots$$
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots\dots\dots\dots$$

- A parallel circuit has two or more loops through which current can pass. If the circuit is disconnected in one of the loops, the current can still pass through the other loop(s). The **wiring in a house** consists of **parallel circuits.**

CONDUCTANCE

- Conductance of a material is the property of a material to aid the flow of charges and hence, the passage of current in it. The conductance of a material is mathematically defined as the reciprocal of its resistance (R).

ELECTRICAL POWER

- Electric power is defined as the rate at which electric energy is dissipated or consumed in an electric circuit

P=VI

- **SI unit** of electric power is **watt**. One watt of power is consumed when 1 A of current flows at a potential difference of 1 V.

  1 W = 1 volt × 1 ampere = 1 V A

- The unit '**watt'** is very small. Therefore, in actual practice we use a much larger unit called '**kilowatt'**. It is equal to 1000 watts. Since electrical energy is the product of power and time, the unit of electric energy is, therefore, **watt hour (W h).** One watt hour is the energy consumed when **1 watt of power** is used for **1 hour.**
- The commercial unit of electric energy is kilowatt hour

  $1KWH=3.6*10^6$ J

- One horse power is equal to 746 watts.

HEATING EFFECT OF CURRENT

- A source of electrical energy can develop a potential difference across a resistor, which is connected to that source. This potential difference constitutes a current through the resistor. For continuous drawing of current, the source has to continuously spend its energy. A part of the energy from the source can be converted into useful work and the rest will be converted into heat energy. Thus, the passage of electric current through a wire, results in the production of heat. This phenomenon is called **heating effect of current.**
- The heat produced depends on the amount of resistance offered by the wire.
- Copper wire offers very little resistance and does not get heated up quickly. On the other hand, thin a wire of tungsten or nichrome which are used in bulbs offer high resistance and gets heated up quickly. This is the reason why tungsten wire is used in the filaments of the bulbs and nichrome wire is used as a heating element in household heating appliances.
- Heating effect of electric current can be seen in many devices. Some of them are given below
  1. Electric laundry iron
  2. Electric toaster
  3. Electric oven
  4. Electric kettle
  5. Electric heater

Joule's Law of Heating

- Joule's law of heating

  H = I2 R t

- Joule's law of heating states that the heat produced in any resistor is:
  1. Directly proportional to the square of the current passing through the resistor.
  2. Directly proportional to the resistance of the resistor.
  3. Directly proportional to the time for which the current is passing through the resistor.

Applications of Heating Effect

ELECTRIC HEATING DEVICE

- The heating effect of electric current is used in many home appliances such as electric iron, electric toaster, electric oven, electric heater, geyser, etc. In these appliances **Nichrome**, which is an alloy of **Nickel and Chromium** is used as the heating element. Because
  (i) It has high resistivity, (ii) It has a high melting point, (iii) It is not easily oxidized

FUSE

- Fuse is the most important safety device used for protecting the circuits due to Short circuiting or overloading of the circuits
- The Joule heating that takes place in the fuse melts it to break the electric circuit
- Fuse is a strip of alloy wire which is made up of lead and tin with a very low melting point. This can be connected to the circuit. The fuse is usually designed to take specific amount of current. When current passing through the wire exceeds the maximum limit, it gets heated up. Due to low melting point it melts quickly disconnecting the circuit. This prevents damage to the appliances.
- The fuse wire is usually encased in a cartridge of porcelain or similar material with metal ends.
- The fuse wire is fitted in a porcelain casing because porcelain is an insulator of electricity.
- The fuse wire is connected in series in an electric circuit
- The fuses used for domestic purposes are rated as 1 A, 2 A, 3 A, 5 A, 10 A, etc

MAGNETIC EFFECTS OF ELECTRIC CURRENT

- A wire or a conductor carrying current develops a magnetic field perpendicular to the direction of the flow of current. This is called **magnetic effect of current.**

Hans Christian Oersted

- Hans Christian Oersted, one of the leading scientists of the 19th century, played a crucial role in understanding electromagnetism. In 1820 he accidentally discovered that a compass needle got deflected when an electric current passed through a metallic wire placed nearby. Through this observation Oersted showed that electricity and magnetism were related phenomena. His research later created technologies such as the radio, television and fiber optics. The unit of magnetic field strength is named the oersted in his honor.

- **Electric current carrying wire** behaves like a **magnet**
- The region surrounding a magnet in which the force of the magnet can be detected is said to have a magnetic field
- Magnetic field is a quantity that has both direction and magnitude. Magnetic field lines are closed curves.

- The pattern of the magnetic field around a conductor due to an electric current flowing through it depends on the shape of the conductor. The magnetic field of a solenoid carrying a current is similar to that of a bar magnet
- An electromagnet consists of a core of soft iron wrapped around with a coil of insulated copper wire
- A current carrying conductor when placed in a magnetic field experiences a force. If the direction of the field and that of the current are mutually perpendicular to each other, then the force acting on the conductor will be perpendicular to both and will be given by Fleming's left hand rule. This is the basis of an electric motor. An electric motor is a device that converts electric energy into mechanical energy.
- Stretch the thumb, fore finger and middle finger of your right hand mutually perpendicular to each other. If the fore finger indicates the direction of magnetic field and the thumb indicates the direction of motion of the conductor, then the middle finger will indicate the direction of induced current. Fleming's Right hand rule is also called 'generator rule'.
- **A generator** converts mechanical energy into electrical energy. It works on the basis of **electromagnetic induction.**
- **Transformer** is a device used for converting low voltage into high voltage and high voltage into low voltage. It works on the principle of **electromagnetic induction**.

Magnetism in medicine

- An electric current always produces a magnetic field. Even weak ion currents that travel along the nerve cells in our body produce magnetic fields. When we touch something, our nerves carry an electric impulse to the muscles we need to use. This impulse produces a temporary magnetic field. These fields are very weak and are about one-billionth of the earth's magnetic field. Two main organs in the human body where the magnetic field produced is significant, are the **heart and the brain**. The magnetic field inside the body forms the basis of obtaining the images of different body parts. This is done using a technique called **Magnetic Resonance Imaging (MRI).** Analysis of these images helps in medical diagnosis. Magnetism has, thus, got important uses in medicine.

Galvanometer

- A galvanometer is an instrument that can detect the presence of a current in a circuit. The pointer remains at zero (the centre of the scale) for zero current flowing through it. It can deflect either to the left or to the right of the zero mark depending on the direction of current.

CHEMICAL EFFECTS OF ELECTRIC CURRENT

- Some liquids are good conductors of electricity and some are poor conductors.
- Most liquids that conduct electricity are solutions of acids, bases and salts.
- The water that we get from sources such as taps, hand pumps, wells and ponds is not pure. It may contain several salts dissolved in it. Small amounts of mineral salts are naturally present in it. This water is thus a good conductor of electricity. On the other hand, distilled water is free of salts and is a poor conductor.
- The passage of an electric current through a conducting liquid causes chemical reactions. The resulting effects are called chemical effects of currents.
- The passage of an electric current through a conducting solution causes chemical reactions. As a result, bubbles of a gas may be formed on the electrodes. Deposits of metal may be seen on electrodes. Changes of colour of solutions may occur. The reaction would depend on what solution and electrodes are used. These are some of the chemical effects of the electric current.

- In 1800, a British chemist, William Nicholson (1753–1815), had shown that if electrodes were immersed in water, and a current was passed, bubbles of oxygen and hydrogen were produced. Oxygen bubbles formed on the electrode connected to the positive terminal of the battery and hydrogen bubbles formed on the other electrode.

Electroplating

- The process of depositing a layer of any desired metal on another material, by means of electricity, is called electroplating. It is one of the most common applications of chemical effects of electric current. Electroplating is a very useful process. It is widely used in industry for coating metal objects with a thin layer of a different metal.
- Jewellery makers electroplate silver and gold on less expensive metals. These ornaments have the appearance of silver or gold but are much less expensive.
- Tin cans, used for storing food, are made by electroplating tin onto iron. Tin is less reactive than iron. Thus, food does not come into contact with iron and is protected from getting spoilt.
- Iron is used in bridges and automobiles to provide strength. However, iron tends to corrode and rust. So, a coating of zinc is deposited on iron to protect it from corrosion and formation of rust.

In the electroplating factories the disposal of the used conducting solution is a major concern. It is a polluting waste and there are specific disposal guidelines to protect the environment.

DOMESTIC ELECTRIC CIRCUIT

- The electricity produced in power stations is distributed to all the domestic and industrial consumers through overhead and underground cables

- In India, domestic circuits are supplied with an alternating current of potential 220/230V and frequency 50 Hz
- The electricity is brought to houses by two insulated wires. Out of these two wires, one wire has a **red insulation** and is called the '**live wire'** (or positive). The other wire has a **black insulation** and is called the '**neutral wire'** (or negative).
- The potential difference between the two is 220 V
- It should be noted that all the circuits in a house are connected in parallel, so that the disconnection of one circuit does not affect the other circuit. One more advantage of the parallel connection of circuits is that each electric appliance gets an equal voltage.
- In domestic circuits, a third wire called the **earth wire** having a **green insulation** is usually connected to the body of the metallic electric appliance. The other end of the earth wire is connected to a metal tube or a metal electrode, which is buried into the Earth. This wire provides a low resistance path to the electric current. The earth wire sends the current from the body of the appliance to the Earth, whenever a live wire accidentally touches the body of the metallic electric appliance. Thus, the earth wire serves as a protective conductor, which saves us from electric shocks.

SOURCES OF ENERGY

- Nature has provide variety of natural sources of energy and energy can be converted from one form to another
- Good source of energy is
    - Which would do a large amount of work per unit volume or mass,
    - Be easily accessible,
    - Be easy to store and transport, and
    - Perhaps most importantly, be economical
    - Less combustile

SOURCES OF ENERGY

1. Conventional sources of energy
2. Non-conventional sources of energy

CONVENTIONAL SOURCES OF ENERGY

- Conventional Sources of energy are also called as nonrenewable sources
- Coal, petroleum, Natural gas, Nuclear energy

NON CONVENTIONAL SOURCES OF ENERGY

- Nonconventional Sources of energy are also called as renewable sources
- Solar energy
- Wind energy
- Tidal energy
- Geothermal energy
- Biomass energy

FOSSIL FUELS

- The fossil fuels are non-renewable sources of energy
- Air pollution caused by burning of coal or petroleum products. The oxides of carbon, nitrogen and sulphur that are released on burning fossil fuels are acidic oxides. These lead to acid rain which affects our water and soil resources

BIO MASS

- Biomass is plant-based material used as fuel to produce heat or electricity
- Cow-dung, various plant materials like the residue after harvesting the crops, vegetable waste and sewage are decomposed in the absence of oxygen to give **bio-gas.** Since the starting material is mainly cow-dung, it is popularly known as **'gobar-gas'.**
- Bio-gas is an excellent fuel as it contains up to 75% methane. It burns without smoke, leaves no residue like ash in wood, charcoal and coal burning. Its heating capacity is high. Bio-gas is also used for lighting. The slurry left behind is removed periodically and used as excellent manure, rich in nitrogen and phosphorous. The large-scale utilisation of bio-waste and sewage material provides a safe and efficient method of waste-disposal besides supplying energy and manure.

WIND ENERGY

- Wind is used to produce electricity using the kinetic energy created by air in motion. This is transformed into electrical energy using wind turbines or wind energy conversion systems.
- Denmark is called the country of 'winds'. More than 25% of their electricity needs are generated through a vast network of windmills. In terms of total output, Germany is the leader, while India is ranked fifth in harnessing wind energy for the production of electricity. It is estimated that nearly 45,000 MW of electrical power can be generated if India's wind potential is fully exploited. The largest wind energy farm has been established near Kanyakumari in Tamil Nadu and it generates 380 MW of electricity.

SOLAR ENERGY

- The Sun has been radiating an enormous amount of energy at the present rate for nearly 5 billion years and will continue radiating at that rate for about 5 billion years more. Only a small part of solar energy reaches the outer layer of the earth's atmosphere. Nearly half of it is absorbed while passing through the atmosphere and the rest reaches the earth's surface.

- India is lucky to receive solar energy for greater part of the year. It is estimated that during a year India receives the energy equivalent to more than 5,000 trillion kWh. Under clear (cloudless) sky conditions, the daily average varies from 4 to 7 kWh/m^2. The solar energy reaching unit area at outer edge of the earth's atmosphere exposed perpendicularly to the rays of the Sun at the average distance between the Sun and earth is known as the solar constant. It is estimated to be approximately 1.4 kJ per second per square metre or 1.4 kW/m^2.

NUCLEAR ENERGY

Nuclear Fission

- In a process called nuclear fission, the nucleus of a heavy atom (such as uranium, plutonium or thorium), when bombarded with low-energy neutrons, can be split apart into lighter nuclei. When this is done, a tremendous amount of energy is released if the mass of the original nucleus is just a little more than the sum of the masses of the individual products. The fission of an atom of uranium, for example, produces 10 million times the energy produced by the combustion of an atom of carbon from coal.
- In a nuclear reactor designed for electric power generation, such nuclear 'fuel' can be part of a self-sustaining fission chain reaction that releases energy at a controlled rate. The released energy can be used to produce steam and further generate electricity.

- The major hazard of nuclear power generation is the storage and disposal of spent or used fuels – the uranium still decaying into harmful subatomic particles (radiations). Improper nuclear-waste storage and disposal result in environmental contamination. Further, there is a risk of accidental leakage of nuclear radiation. The high cost of installation of a nuclear power plant, high risk of environmental contamination and limited availability of uranium makes large-scale use of nuclear energy prohibitive.
- Nuclear energy was first used for destructive purposes before nuclear power stations were designed. The fundamental physics of the fission chain reaction in a nuclear weapon is similar to the physics of a controlled nuclear reactor, but the two types of device are engineered quite differently.

Nuclear fusion

- Currently all commercial nuclear reactors are based on nuclear fission. But there is another possibility of nuclear energy generation by a safer process called nuclear fusion. Fusion means joining lighter nuclei to make a heavier nucleus, most commonly hydrogen or hydrogen isotopes to create helium.
- Such nuclear fusion reactions are the source of energy in the Sun and other stars. It takes considerable energy to force the nuclei to fuse. The conditions needed for this process are extreme – millions of degrees of temperature and millions of pascals of pressure.
- The **hydrogen bomb** is based on thermonuclear **fusion reaction**. A nuclear bomb based on the

fission of uranium or plutonium is placed at the core of the hydrogen bomb. This nuclear bomb is embedded in a substance which contains deuterium and lithium. When the nuclear bomb (based on fission) is detonated, the temperature of this substance is raised to 107 K in a few microseconds. The high temperature generates sufficient energy for the light nuclei to fuse and a devastating amount of energy is released.

Magnets

- The substances having the property of attracting iron are now known as magnets.
- Magnetite is a natural magnet.
- The materials which get attracted towards a magnet are magnetic – for example, iron, nickel or cobalt.
- The materials which are not attracted towards a magnet are non-magnetic.
- A freely suspended magnet always aligns in N-S direction.
- Opposite poles of two magnets attract each other whereas similar poles repel one another
- The end of the magnet that points towards North is called its North seeking end or the North Pole of the magnet. The other end that points towards the South is called South seeking end or the South Pole of the magnet.
- The earth behaves as a magnet with the magnetic field pointing approximately from the geographic south to the north. When a bar magnet is freely suspended, it points in the north-south direction. The tip which points to the geographic north is called the North Pole and the tip which points to the geographic south is called the south pole of the magnet.
- Magnets lose their properties if they are heated, hammered or dropped from some height. Also, magnets become weak if they are not stored properly.

INVENTIONS AND DISCOVERIES

Inventions	**Inventors**
Adding machine	Pascal
Aeroplane	Wright brothers
Ball point pen	John Loud

Anemometer	Leon Battista Alberti
Air brake	George Westinghouse
Barometer	Evangelista Torricelli
Bicycle	Macmillan
Calculating machine	Blaise Pascal
Diesel engine	Rudolf Diesel
Electric tram	Fyodor Pirotsky
Dynamite	Alfred Nobel
Dynamo	Michael Faraday
Electric battery	Alessandro Volta
Electricity	Benjamin Franklin
Electric generator	Michael Faraday
Fountain pen	Lewis Edson Waterman
Jet engine	Frank Whittle
Lift or Elevator	Elisha Otis
Lightning conductor	Benjamin Franklin
Machine gun	Jordan Gatling
Mercury thermometer	Daniel Gabriel Fahrenheit

Paper clips	Johan Vaaler
Braille	Louis Braille
Radio	Guglielmo Marconi
Radium	Marie curie
Railway engine	George Stephenson
Raman effect	C.V.Raman
Revolver	Samuel Colt
Sewing machine	Thomas Saint
Steam engine	James watt
Telescope	Hans Lippershey
Television	John Logie Baird
X-rays	Wilhelm Conrad Roentgen
Vernier caliper	Pierre Vernier

PHYSICS ONE LINERS

- In summer, the mirages are seen due to the phenomenon of Total Internal Reflection
- In the visible spectrum Red colour has the longest wavelength.
- Sound travels faster in solids
- Insects can move on the surface of water without sinking due to Surface tension of water
- Liquid droplets isspherical structure due to the surface tension of water
- Light travels in a Straight line
- Water is used as a cooling agent in most of the world's nuclear power plants

- Working principle of transformer is Mutual Induction
- Distance between Earth and Sun is known as 1 Astronomical unit
- Potential energy of your body is minimum when you on ground
- Radian is the unit of an Angle
- Radio waves of constant amplitude can be generated with an Oscillator
- Water moving up a straw is an example of Capillary Action
- Sudden fall in barometer is indication of strom
- Hooke’s law is related to Elasticity
- Blue colour of the clear sky is due to Dispersion of Light
- Filament string in an electric bulb is made of Tungsten
- Hydraulic brake used in automobiles is a direct application of Pascal’s Law
- The image formed by convex lens in a simple microscope is Virtual & Erect
- Convex mirror is used in motor vehicles near the driver’s seat
- From the moon’s surface Astronauts see a Black Sky. This is because of Absence of Atmosphere on Moon
- Specific resistance of a wire varies with its material
- Pyrometer is used to measure the temperature of the sun
- Total Internal reflection occurs when light passes from a denser to rarer medium
- Value of Specific Gravity remains same in all system of units
- The speed of sound in air is about 343 metres per second
- During a fog the visibility is reduced because of Scattering of light.
- Weightlessness experienced in a spaceship is due to Absence of Gravity
- SONAR is used to find submerged objects
- Unit of power of lens is Dioptre
- An object has to attain the velocity of 11.2 km/sec to escape from earth’s atmosphere
- Angstrom is the measuring unit of length of light waves.
- Weber is the unit of magnetic flux
- Ohm-metre is the unit of specific resistance
- The wavelength of visible spectrum ranges from390-700 nanometres
- A Washing machine works on the principle of Centrifugation
- Magnifying glass is made of Convex lens
- Magnetite is the only natural magnet
- Nephelometer is used to measure the scattering of light by particles suspended in a liquid
- Fathometer is used to measure depth of ocean
- Dilatometer is used to measure change in volume of substances
- Altimeter is used to measure altitudes in aircrafts

- Red glass is heated in dark room it will seem Green colour
- The value of acceleration due to gravity is maximum at poles
- Escape velocity of Moon is 2.38 Km/s
- Resistance of a Conductor is inversely proportional to its Cross Sectional Area and directly proportional to length
- Nuclear Fissions are initiated by Neutrons
- National physical laboratory is located in New delhi
- Higgs bosonis known as God particle
- Enrico Fermi is inventor of nuclear reactor
- A viscometer is an instrument used to measure the viscosity of a fluid
- Gold was used in the Rutherford's alpha particle scattering experiment
- Alpha rays have the highest ionising power
- Gamma rays have the highest penetrating power
- SI unit of radioactivity is becquerel
- Hydrogen isotope named as Tritium
- The fuse in an electric circuit is connected in series with live
- Ball pen function on the principle of surface tension and capillarity
- Bat can fly dark because they produce ultrasonic wave
- Infrared rays of the sunlight makes the solar cooker hot
- Centripetal force acts on the body moving in circular path
- Mirage is an optical illusion
- In radio transmission FM stands for Frequency Modulation
- Tidal wave on sea is mainly due to Gravitational effect of moon on earth
- Light year is unit of distance
- A train starts suddenly the passengers bends backwards is example of inertia
- Optical fibre works on the principle of Total internal reflection
- Kepler’s law governs motion of planet
- Sparkling of diamond due to total internal reflection
- Reason for a swimming pool appear less deep than actual depth is refraction
- Energy released by the sun and other star due to nuclear fusion
- Microphone converts sound energy into electrical energy
- Law of inertia also called newton first law
- Blue colour of sky due to dispersion
- If magnet has a third pole then the third pole is called consequent pole
- Astigmatism is corrected by cylindrical lens

- Light from laser is monochromatic
- Weight of body maximum at pole
- Microwave is used in oven
- Doppler's effect is related to the change in frequency of sound
- A moving electric charge produce electric and magnetic field
- Black hole theory is given by Stephen hawking
- Einstein's mass energy equivalence is based on theory of relativity
- Physical quantity which have magnitude and direction and obey triangle law is called vector quantity
- Hydraulic lift, Hydraulic press and Hydraulic works on Pascal law
- Soap bubble obtain spherical shape due to surface tension
- Reed,Green,Blue are primary colours
- Newton's second law of motion gives measure of force
- A clean and dry needle is kept on the surface of water it floats due to surface tension
- A person is not able to see distinct as well as nearby objects is suffering from presbyopia
- Minimum distance required to hear an echo 17 meter
- When a body is moving along a circular path with constant speed work done on it is zero
- Pure water freezes at 32 degrees farenheit
- Recoil of gun is example of conservation of linear momentum
- Archimedes principle is related to laws of floatation
- Odometer is used to measure distance
- Twinkling of star is a example of refraction
- Red light is used in traffic signal because Long wavelength
- Electric bulb filament made of tungsten
- Galvanometer can be converted into voltmeter by connecting High resistance in series
- Light stands for Light amplification by stimulated emission of radiation
- Fat can be separated from milk by centrifugal force
- Hydrogen bomb is based on nuclear fusion
- Loudness of sound based on amplitude
- At 4 Degree celsius density of water is maximum
- Stone falling towards earth both stone and earth attract each other
- Soft iron is used to making electromagnet
- Gamma rays have minimum wavelength
- Parsec is a unit of Astronomical distance
- Soap bubble appear coloured due to interference
- Longitudinal waves cannot travel through vaccum

- Surface tension is the tendency of liquid surfaces to shrink to have minimum surface area as mush as possible.
- Atmospheric pressure can be measured by a device called barometer..
- The barometer was invented by Torricelli
- Friction is the force that opposes the motion of an object.