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ODISHA PUBLIC SERVICE COMMISSION

ODISHA PANCHAYATI RAJ ENGINEERING SERVICE

Asst. Executive Engineer (Civil) in Group -A

GENERAL STUDIES

with ***Special reference to Odisha***

Comprehensive Theory
with **Practice Questions**

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Odisha Panchayati Raj Engineering Service Asst. Executive Engineer (Civil) in Group -A: General Studies *with Special reference to Odisha*

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Preface

B. Singh (Ex. IES)

The compilation of this book **General Studies *with Special reference to Odisha*** is motivated by the desire to provide a concise book which can benefit students who are preparing for Odisha Panchayati Raj Engineering Service (Asst. Executive Engineer (Civil) in Group -A) Examination.

This textbook provides all the requirements of the students, i.e. comprehensive coverage of General Studies topics and objective types questions articulated in a lucid language. This book not only covers the syllabus of Odisha Panchayati Raj Engineering Service in a holistic manner but is also useful for other competitive examinations. All the topics are given the emphasis they deserve so that mere reading of the book helps aspirants immensely.

Our team has made their best efforts to remove all possible errors of any kind. Nonetheless, we would highly appreciate and acknowledge if you find and share with us any printing and conceptual errors.

It is impossible to thank all the individuals who helped us, but we would like to sincerely thank all the authors, editors and reviewers for putting in their efforts to publish this book.

With Best Wishes

B. Singh

CMD, MADE EASY Group

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with Special reference to Odisha

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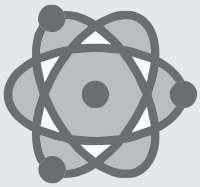
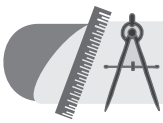
Part I

CHAPTER 1

Physics



Physics is a branch of science which is concerned with all aspects of nature on both the microscopic and macroscopic level. Its scope of study encompasses not only the behavior of objects under the action of forces but also the nature of gravitational, electromagnetic, nuclear forces among others.
The ultimate objective of physics is to formulate comprehensive principles that bring together and explain all such phenomena.



UNITS & MEASUREMENT

- Unit is the chosen standard used for measuring a physical quantity.
- There are basically two types of unit:
  1. **Fundamental Unit:** These units are a set of measurements, defined arbitrarily and from which other units are derived. Examples: meter, kilogram, second, etc.
     The fundamental unit of some of the physical quantities are given below:

International System of Units (S.I.)		
Physical	**Fundamental**	**Symbol**
Mass	Kilogram	kg
Length	Metre	m
Time	Second	s
Temperature	Kelvin	K
Electric-current	Ampere	A
Luminous intensity	Candela	Cd
Quantity of matter	Mole	mol

Systems of units	Length	Mass	Time
C.G.S. System	Centimetre	Gram	Second
F.P.S. System	Foot	Pound	Second
M.K.S. System	Metre	Kilogram	Second

  2. **Derived Unit:** All the units which are expressed in terms of fundamental units are known as derived units. Examples: Newton, Joule, etc.
- Internationally, there are four types of unit systems. These are:
  1. **S.I. Units/System:** It is the modern form of the metric system, and is the most widely used system of measurement. It comprises a coherent system of units of measurement built on seven base units namely kilogram, meter, second, candela, ampere, kelvin and mol.
  2. **CGS System:** The centimeter-gram-second (CGS) system of units is a variant of the metric system based on centimetre as the unit of length, gram as unit of mass, and the second as the unit of time.
  3. **FPS System:** The foot-pound-second (FPS) system is a system of units built on three fundamental units: the foot for length, the pound for mass and the second for time.
  4. **MKS System:** The MKS system of units is a physical system of units that expresses any given measurement using base units of the metre, kilogram, and second.

MOTIONS

Basics of Motion

A body is said to be in motion if it changes its position with respect to its surroundings as time goes on. A body is said to be at rest if it does not change its position with time, with respect to its surroundings.

Types of Motion

(i) When a particle or a body moves along a straight path, its motion is Rectilinear or translatory motion.

(ii) When a particle or a body moves in a circular path, its motion is circular motion. When a body spins about its own axis, it is said to be in rotational motion.

(iii) When a body moves to and fro or back and forth repeatedly about a fixed point in a definite interval of time, it is said to be in vibrational or oscillatory motion.

Speed

The time rate of change of position of an object in any direction i.e. the rate of change of distance of an object with respect to time is known as speed.

$$\text{Speed} = \frac{\text{displacement}}{\text{time taken}}$$

Velocity

The rate of change of displacement of an object with respect to time is known as velocity.

$$\text{Velocity} = \frac{\text{displacement}}{\text{time}}$$

Acceleration

The rate of change of velocity with respect to time is called acceleration.

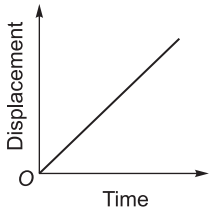
$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{time taken}}$$

When a body completes equal displacement in equal interval of time, its velocity is constant and hence, it does not have an acceleration. When a body shows equal change in velocity in equal interval of time its velocity is not constant but it has a constant acceleration.

Position (Displacement)-Time Graphs

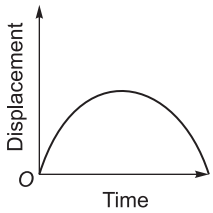
For a body moving with a uniform velocity

This graph comes as a straight line because in a uniform velocity the particle completes equal displacement in an equal interval of time.



For the motion of a body thrown vertically upwards

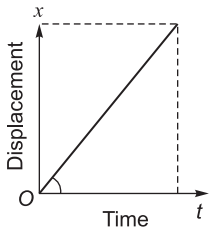
When the body moves up, its velocity continuously decreases due to gravity and finally becomes zero at the maximum height. Then, the body falls with an increasing velocity.



The slope of the position time graph is equal to the uniform velocity.

$$\text{Slope} = \frac{\text{Displacement}}{\text{Time}}$$

or $V = \frac{x}{t}$



Physical Quantities

Vectors

They have a definite magnitude and a definite direction, e.g. displacement, velocity, acceleration, force etc.

Scalars

They have definite magnitudes only and not direction. e.g. distance, speed, work, energy, power, electric charge etc.

Tensors

They have different magnitudes in different directions, e.g. Moment of interia, stress etc.

In a motion, a body can have a constant speed but variable velocity like the motion of a body along a circular path. A particle may have zero displacement and zero velocity but non-zero distance and speed. When a body completes one revolution

along a circular path in a given time period, the net displacement and velocity of the body will be zero but the distance and speed of the body must be non-zero.

Linear-Momentum

It is the quantity of motion which a body possesses and is measured as the product of the mass and velocity of the body.

Linear momentum = mass × velocity

Impulse

The total change in momentum is called the impulse. If a very large force acts for a very small time, the product of force and the time is equal to the impulse.

Inertia

The inability of a body to change by itself its state of rest or state of uniform motion along a straight line is called inertia of the body.

The inertia of a body is measured by its mass. Heavier the body, greater is the force required to change its state and hence greater is its inertia. Inertia of a body may be inertia of rest, inertia of motion or inertia of direction.

Newton's Laws of Motion

First Law of Motion

Every body continues to be in a state of rest or uniform motion in a straight line, except in so far as it may be compelled by force to change that state.' Newton's first law of motion defines inertia.

1. **Inertia of Rest :** The inability of a body to change by itself its state of rest.
   - When a branch of a fruit tree is shaken, the fruits fall down. This is because the branch comes in motion and the fruits tend to remain at rest. Hence, they get detached.
   - The dirt particles in a durree fall off if it is stricken by a stick. This is because the striking sets the durree in motion whereas the dirt-particles tend to remain at rest and hence fall.
   - When a train starts suddenly, the passenger sitting inside tends to fall backwards. This is so because the lower part of the passenger's body starts moving with the train but the upper part tends to remain at rest.
   - If a smooth paper having a coin on it placed on a table is suddenly drawn, the coin remains at the same place on the table due to inertia of rest.
   - When a horse starts suddenly, the rider tends to fall backwards due to inertia of rest
2. **Inertia of Motion :** The inability of a body to change by itself its state of uniform motion.
   - When a horse at full gallop stops suddenly, the rider on it falls forward because of inertia of motion of the upper part of the rider's body.
   - When an athelete takes a long jump, he runs first for a certain distance before the jump. This is because his feet come to rest on touching the ground and the remaining body continues to move owing to inertia of motion.
   - When train stops suddenly, a passenger sitting inside tends to fall forward. It happens because the lower part of the passenger's body comes to rest with the train but the upper part tends to continue its motion due to inertia of motion.
   - A person jumping out of a speeding train may fall forward due to inertia of motion of his body. Hence, he should run a few steps on the platform in the direction of motion of train.
3. **Inertia of Direction :** The inability of a body to change by itself its direction of motion.
   - The wheels of any moving vehicle throw out mud, if any, tangentially, due to the inertia of direction. The mud-guards over the wheels stop this mud, protecting the clothes, etc. of the person sitting on the bike.
   - Use of an umbrella to protect us from rain is based on the property of inertia of direction because the rain drops cannot change their direction of motion.
   - When a bus or a car rounds a curve suddenly, the person sitting inside is thrown outwards. It happens so because the person tries to maintain his direction of motion due to directional inertia while the vehicle turns.
   - When a knife is sharpened by pressing it against a grinding stone, the sparks fly off tangentially because of the inertia of direction.

- When a stone tied to one end of a string is whirled and the string breaks suddenly, the stone spins off along the tangent of its circular path. It happens so because of the pull in the string was forcing the stone to move in a circle. As soon as the string breaks, the pull disappears. The stone becomes free and in a bid to move along the straight line flies off tangentially.

Second Law of Motion

The rate of change of linear momentum of a body is directly proportional to the external force applied on the body and this change takes place always in the direction of the applied force'.

The second law gives us a measure of force. When a force is applied on a body, its momentum and hence, velocity change. The change in velocity produces an acceleration in the body. The rate of change of linear momentum with time is equal to the product of the mass of the body and its acceleration which measures the magnitude of the applied force i.e.

$$\text{Force} = \frac{\text{Change in linear momentum}}{\text{time interval}}$$

$$= \text{mass} \times \text{acceleration}$$

or, $$F = ma$$

Third Law of Motion

''To every action, there is always, an equal and opposite reaction.''

Here, the action is the force exerted by one body on the other body while the reaction is the force exerted by the second body on the first.

Principle of Conservation of Linear Momentum

The total sum of the linear momentum of all bodies in a system remains constant and is not affected due to their mutual action and reaction. It means in a system of the two bodies, the total momentum of the bodies before impact is equal to the total momentum of the two bodies after impact. The law of conservation of linear momentum is universal i.e. it applies to both, the microscopic as well as macroscopic system.

Uniform Circular Motion

When a body moves along a circular path or a curve with a uniform circular speed, the body is acted upon by an inward acceleration. This acceleration acts towards the centre of a circular path or curve and is called as radial or centripetal acceleration which gives rise to the centripetal force. The centripetal force is an essential condition of the circular motion. Centripetal force (F_c) = mass of the body (m) × centripetal acceleration (a_c)

or $$F_c = ma_c$$

Centripetal acceleration

$$a_c = \frac{v^2}{r} = rw^2$$

where v = linear speed, w = angular speed or, r = radius of circular path or curve.

$$\therefore \quad F_c = ma_c = \frac{mv^2}{r} = mvw = mrw^2$$

The centripetal force acting on a body is an action and an equal and opposite force called centrifugal force appears as a reaction.

Rotational Motion

Torque (Moment of Force)

The product of force acting on a body and perpendicular distance of line of action of the force from the axis of rotation is called moment of force or torque.

Torque = Force × Perpendicular distance from axis rotation

Angular Momentum

It is equal to the product of linear momentum of a body and the perpendicular distance from the axis of rotation. It follows the principle of conservation. It means the total angular moment of an isolated system remains always constant.

Friction

When a body moves (slides or rolls) or even tries to move over the surface of another body a tangential force comes into action between their surfaces in contact, against their relative motion. This opposing force is termed as the force of friction.

The force of friction depends upon the mass of the body on a surface and roughness of the surfaces in contact between them and the magnitude of friction, which increases with increase in roughness and mass.

When a body is at rest on a surface, the friction is called static friction which is a self adjusting force. When the body is on the verge to move (slide or roll), the friction is called limiting friction but when the body moves, it gives rise to dynamic friction.

The limitting friction is the maximum force of friction and it is always more than static or dynamic friction.

Usually, smoothness decreases the force of friction. However, when the surfaces in contact are made too smooth by polishing, the binding force of adhesion increases and hence, the frictional force increases. This is called 'cold welding'.

Friction is a non-conservative force and hence, the mechanical energy (potential and kinetic energy) is not conserved. In fact, friction converts mechanical energy partly into heat, light (spark), sound, electricity, etc.

Generally, friction opposes motion. However, in certain cases friction is essential for motion. Without friction, motion cannot be started, stopped or transferred from one body to the other. Thus, friction is a necessary evil.

WORK, POWER & ENERGY

Work

When a force is applied on a body and a displacement is carried out in any direction except in a direction perpendicular to the direction of the force, an amount of work is done by the force.

The amount of work done is equal to the product of the force and the distance travelled in the direction of the applied force i.e.

$$\text{Work} = \text{Force} \times \text{distance travelled}$$

or, $$W = F \times S$$

Unit of work is Joule 1 joule = 1 Newton × 1 metre.

Work done by a force may be zero, positive or negative depending upon the direction of the applied force and displacement.

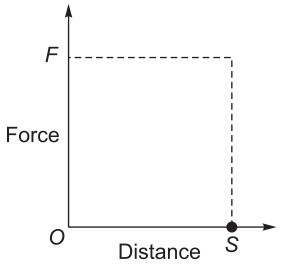
Power

The time rate of change of work is power. When a body takes less time to do a certain work, its power is said to be more and vice-versa.

$$\text{Power} = \frac{\text{work}}{\text{time}}$$

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

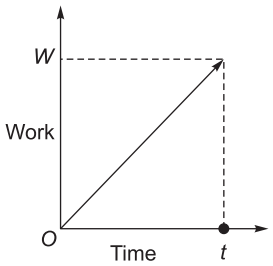
Its unit is watt (w). One kilowatt (1 kw) is equal to 1000 watt. One horse power (h.p.) is equal to 746 watt. Power of an agent measures how fast it can do the work. The area under the force versus distance graph is numerically equal to the work done by the agent.



$$\text{Work} = \text{Force} \times \text{Distance}$$

$$W = F \times S$$

The area under power-time graph gives the work done while the slope of work versus time graph gives the power.



Work = power × time

= area under W-t graph

or, $$W = Pt$$

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

or, $$P = w/t = \text{slope of } W\text{-}t \text{ graph}$$

Energy

The ability of a body to do work is called energy. When a body can do more work, it is said to have more energy and vice versa. Energy is different from power. Energy refers to the total amount of work a body can do and power determines the rate of doing work. Both the energy of a body and work done by the body are equivalent and are measured in Joule (J).

Kinetic Energy (K.E.)

It is the energy possessed by the body by virtue of its motion. The kinetic energy of a body is given as

$$\text{K.E.} = \frac{1}{2}mv^2$$

Where m = mass of the body and v = velocity of the body. Thus, K.E. of a body is equal to half the product of mass of the body and square of velocity of the body. The change in K.E. of a body measures the work done by the body.

Work = change in K.E. of the body

or, $$W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

Where u and v are initial and final velocities of the body of mass m.

When a heavy and a tight body are moving with same K.E. and same retarding force is applied on each, both the bodies will stop after travelling the same distance.

K.E. of a body is also given as :

$$\text{K.E.} = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

or, $$\text{K.E.} = \frac{P^2}{2m}$$

Hence, when a light and a heavy body are moving with the same linear momentum, the light body will have more K.E.

Every moving system is associated with a definite amount of K.E. e.g. a moving vehicle, wind, water flow, etc.

Potential Energy (P.E.)

The energy possessed by a body by virtue of its position or configuration is known as its potential energy. The mechanical P.E. is of two types viz., gravitational P.E. and elastic P.E. The gravitational P.E. of a body at a certain height is due to gravity whereas the elastic P.E. is due to its property of elasticity.

Gravitation P.E. = mass × acceleration due to gravity × height = mgh

At the surface of the earth, $h = 0$, $\therefore$ P.E. = 0

Different Forms of Energy

1. **Heat :** It is the energy possessed by a body by virtue of random motion of the molecules or particles of the body.
2. **Internal Energy :** It is the energy of a body due to the molecular configuration and molecular motion.
3. **Electrical Energy :** This energy arises due to work done in moving free charge carriers in a particular direction through a conductor.
4. **Chemical Energy :** It is the energy possessed by the body by virtue of chemical bonding of its atoms.
5. **Nuclear Energy :** It is the energy released during the nuclear reaction due to conversion of mass into energy.

Pressure is defined as force acting normally on unit area of the surface. SI unit of pressure is N/m^2 also called Pascal (***Pa***). Pressure is an scalar quantity.

$$\text{Pressure } (P) = \frac{F}{A} = \frac{\text{Normal force acting on the surface}}{\text{Area of the surface}}$$

Atmospheric Pressure

Atmospheric pressure is that pressure which is exerted by the atmospheric gases and measured by a mercury column of 76 cm length at 0°C at 45° latitude at the sea-level. It is equal to weight of 76 cm column of mercury of cross-section area 1 cm^2. Generally, it is measured in bar.

Atmospheric pressure 1atm = 1.01bar=1.01×10^5 N/m^2

Do You Know?

- It is difficult to cook on the mountain as the pressure is low on mountain in comparison to plain areas as atmospheric pressure decreases with the increase of height.
- The fountain pen of a passenger leaks in aeroplane at height, due to reduction in atmospheric pressure.

Measurement of Pressure

- Barometer measures the atmospheric pressure.
- Sudden fall in barometric reading is the indication of storm.
- Slow fall in barometric reading is the indication of rain.
- Slow rise in the barometric reading is the indication of clear weather.

Pascal's Law of Pressure

It states that "the pressure exerted anywhere at a point of confined fluid is transmitted equally in all directions throughout the liquid". Examples: Hydraulic lift, hydraulic press, hydraulic brake, etc. work on the Pascal's law.

Effects:

- If gravitational attraction is negligible in equilibrium condition, pressure is same at all points in a liquid.
- If an external pressure is applied to an enclosed fluid, it is transmitted undiminished to every direction.

Effect of pressure on Melting Point and Boiling Point

(i) The melting point of substances which expands on fusion increases with the increase in pressure. **Example:** Wax.

(ii) The melting point of substances which contracts on fusion decreases with the increase in pressure. **Example:** Ice.

(iii) Boiling point of all the substances increases with the increase in pressure.

Each and every massive body attracts each other by virtue of their masses. This phenomenon is called gravitation.

Newton's Law of Gravitation

The gravitational force of attraction between two bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

$$\textbf{Gravitational force (F)} = G.m_1.m_2/r^2$$

Where G is the gravitational constant = 6.67×10^{-11} Nm^2kg^{-2}, m_1 and m_2 are the masses of two bodies and r is the distance between them.

Acceleration due to Gravity of Earth

The acceleration produced in a body due to the gravitational pull of the earth is called acceleration due to gravity.

$$g = GM/R^2$$

Where M is the mass of the Earth and R is the radius of the Earth.

Note:

- The value of g slightly changes from place to place but its value near the Earth's surface is 9.8 ms^{-2}.
- Gravitational force is the weakest force in nature.

Do You Know?

The Centre of Gravity of a body is that point at which whole weight of the body appears to concentrated.

Mass and Weight

- The mass of a body is the quantity of matter contains in it. Mass is a scalar quantity and its S.I. unit is kg. Mass of a body does not change from place to place.
- The weight of the body is the force with which it is attracted towards the centre of the earth. Weight of the body is a vector quantity and its unit is Newton. The weight of the body is a variable quantity and it changes from place to place.

$$w = mg$$

***Cases*: Weight of a body in a lift:**

- When the lift is at rest or in uniform motion then the apparent weight is equal to the real weight of the body. i.e. $w = mg$.
- When the lift is accelerating upward then apparent weight is greater than the real weight of the body. i.e. $w = m(g + a)$
- When the lift is accelerating downward then the apparent weight of the body is less than the real weight of the body. i.e. $w = m(g - a)$.
- When lift is falling freely under gravity the apparent weight of the body is zero. i.e.

$$w = m(g - g) = 0 \text{ [As } a = g\text{]}$$

Note:

The weight of the body on the moon is lesser than that of on the earth as the acceleration due to gravity at the moon is less than the acceleration due to gravity on earth. The value of g on Earth is 6 times than that of on the moon.

PROPERTIES OF MATTER

Vander Waal Force of Attraction

It is the minimum force of attraction between any two neutral particles (atoms or molecules). It may be of two types viz. cohesive force (between similar molecules) and adhesive force (between dissimilar molecules).

Elasticity

The ability of a body to regain its original configuration after removal of an applied deforming force is called elasticity and the body is termed elastic. Quartz and phospher bronze are nearly perfectly elastic bodies. Steel is more elastic than rubber. Most of the metals are elastic.

When a body does not regain its original configuration at all on the removal of the deforming force, it is called a plastic body. e.g. plastic paraffin, putty, etc.

When a deforming force is applied on an elastic body, its configuration changes and after the removal of the force the body regains the original form. The force applied per unit area is called stress and the ratio of the change in configuration to the original configuration is called strain.

Hooke's Law

Within the elastic limit, the stress developed is directly proportional to the strain produced in a body i.e. stress a strain or stress = $E \times$ strain

or $$E = \frac{\text{stress}}{\text{strain}}$$

Where E is a constant for a given body and known as the co-efficient of elasticity or modulus of elasticity. The modulus of elasticity is a measure of elasticity of a body.

Ductile Materials

These materials show a large plastic range beyond the elastic limit. They are used in making springs and sheets e.g. coppers, iron, silver, aluminium, etc.

Brittle Materials

These materials show a very small plastic range beyond elastic limit e.g. glass, cast iron, etc.

Elastomers : These materials have no plastic range. In such materials even a small stress can produce a large strain e.g. rubber, the elastic tissue of aorta in the human blood circulatory system, etc.

$$\text{Safety factor} = \frac{\text{breaking stress}}{\text{working stress}}$$

When a material is used in a certain construction, the working stress is kept much lower than that of breaking stress so that the safety factor may have a large value. The metallic parts of the machinery are never subjected to a stress beyond the elastic limit, otherwise they will get permanently deformed.

WAVE

Wave is some sort of disturbance in which, information and energy, in the form of signals, propagate from one point to another without the actual journey of the medium. All our communications depend on the transmission of signals through waves. All radiations are waves. Wave motion is a kind of disturbance which travels through a medium on account of repeated periodic vibrations of the medium particles about their mean position without any net transport of the medium.

Types of Waves

On the basis of medium requirement waves are of two types:

1. **Mechanical or Elastic waves :** They require a medium for propagation. e.g. sound, waves on the liquid surface, vibration of string, etc.
2. **Electromagnetic waves :** They do not require a medium for propagation e.g light, X-rays, microwaves, infra-red, ultra-violet rays, etc.

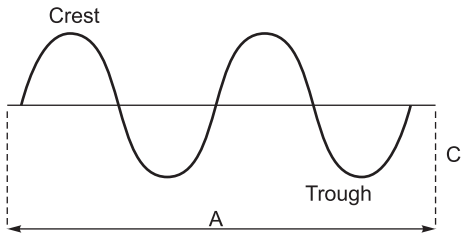
On the basis of the mode of vibration the waves are of two types:

1. **Transverse Wave Motion :** It is the type of wave motion in which the particles of the medium vibrate about their positions in a direction perpendicular to the propagation of the wave. A transverse wave is represented in the form of crest and trough.

When a stone is thrown in a pond, transverse waves are formed. The vibrations of the membrane a of drum, of the string of a sitar, violin etc. produce transverse waves.

2. **Longitudinal Wave Motion :** It is the type of wave motion in which the particles of the medium vibrate about their mean positions in the same direction in which the wave is propagated.

   Sound produced from a source is a longitudinal wave like vibrations of a tuning fork, ringing of a bell, etc. A longitudinal wave is represented in the form of compression and rarefaction.



Transverse Wave

Longitudinal Waves

C = Compression, *R* = Refraction

Wave Length (λ)

For the transverse wave the wave Length is equal to the distance between the two successive crests or troughs.

It is also equal to the sum of the width of a crest and a neighbouring trough.

For the longitudinal wave, the wave length is equal to the distance between the two successive compressions or rarefactions. It is also equal to the sum of the width of a compression and a neighbouring rarefaction.

Time Period (*T*)

It is equal to time interval taken to complete one vibration.

Frequency (*n*)

It is the no. of vibrations produced per second. It is equal to the reciprocal of time period i.e.

$$\text{Frequency} = \frac{1}{\text{Time period}}$$

or $$n = \frac{1}{T}$$

Speed of a wave is given as

$$\text{Speed} = \text{Frequency} \times \text{Wavelength}$$

$$V = n\lambda$$

$$\therefore \quad V = \frac{\lambda}{T}$$

A mechanical transverse wave that requires a medium can propagate through solids and at the surface of liquids, but not inside liquids and gases. However, a longitudinal wave can pass through solids, liquids and gases.

SOUNDS

Sound is produced in a material medium by a vibrating source. These vibrations are carried by air, as a medium and strike our ear drum. The ear drum vibrates and the message is conveyed to our brain and we hear the sound. A sound heard persists for 0.1 second in brain. It is called as persistence of hearing.

Depending upon the frequency range, sound has three categories viz. Infrasonic, Sonic and Ultrasonic or supersonic sounds.

Infrasonic sound has a frequency less than 20 Hz. Sonic sound is between 20 Hz to 20,000 Hz. It is the audible range for human ears. Ultrasonic sound has a frequency greater than 20000 Hz. Both the infrasonic and ultrasonic sounds are not audible to human ear. However, a dog can hear sound of frequency upto 50000 Hz and a bat upto 10^5 Hz. Dolphins can produce and detect sounds of frequency upto 10^5 Hz.

Sound is a longitudinal wave. Its speed in dry air is 332 m/s. The speed of an object greater than the speed of sound is known as supersonic speed. The speed of sound depends upon elasticity, density, temperature and motion of particles of the medium of propagation. Higher the elasticity of a medium, greater is the speed of sound in it e.g. speed of sound in air is 332 m/s and in steel 5000 m/s.

Sonic Boom

Sound produced by a supersonic aircraft is heard as a loud explosion on the earth. It is known as sonic boom. However, a person inside the supersonic aircraft cannot hear its sound.

Reflection of Sound

Sound waves are reflected from the obstacles of size of wavelength of sound and follow laws of reflection similar to those of light. The reflecting obstacles can be walls, mountains, clouds, ground, etc. Sound waves can be focused after reflecting from a curved surface in the same way as light waves.

ECHO

Reflected sound is called echo. An echo occurs when the reflected sound wave comes back to the listener within a time interval of not less than 0.1 second after the original sound wave reaches the listener so that a distinct repetition of the original sound is perceived.

Supersonic Or Ultrasonic Waves

These waves are used :

1. To determine the elastic symmetries of crystals of solids and to detect flaws in metals.
2. to find the velocity of sound in liquids that also informs several physical and chemical properties of the liquids.
3. For finding the depth of sea and to detect the submerged rocks, submarines and icebergs.
4. To form stable emulsions of immiscible like water and oil.
5. To accelerate crystallisation of substances and to produce oxidation.
6. To coagulate aerosols i.e. displaced fine particles of a solid or a liquid in a gas, e.g. dust, smoke, mist, etc.
7. To liquify gels in the same manner as they are liquefied by shaking.
8. In getting alloys of uniform composition.
9. For washing silken fabrics.

Ultrasonography

It is a technique used to form an image or picture of a matter by using ultrasonic waves. This technique is used in medical science treatment. The medical sonography is commonly known as ultrasound. In this technique, ultrasound wave passes through the organs to be diagnosed. The velocity of wave depends upon the elasticity and density of the tissues in the organ and an echo is detected by a specific microphone.

Sound navigation and ranging

It is device that transmits ultransonic waves through water and records the vibrations reflected i.e. echo from an objects. Sonar is used in finding submarines, depth of sea, rocks and mineral deposits, etc.

Biological Effects of Ultrasonic Waves

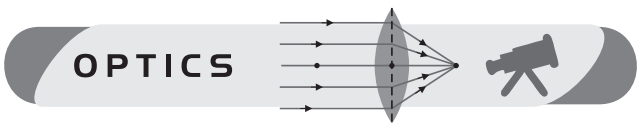
Ultrasonic waves can kill or injure small animals like frog, fish, etc. These waves can destroy micro organisms like bacteria and yeast.

In dental science, ultrasonic waves are used for extracting the broken teeth, to detect cracks or other defects in homogeneity noticeable by reflection or absorption.

Doppler's Effect

When a source of sound and a listener are at rest, the listener receives an unchanged frequency produced by the source. If there is a relative motion between them, then, the number of waves received per second or the apparent frequency of the source changes and is not the same as that of the source.

The pitch of the note heard appears to rise if they approach each other and appears to fall if they recede away from each other. The apparent change in frequency of a sound wave due to a relative motion between the source of sound and the listener is known as Doppler's Effect. It is equally observed for light too.



Light

- Light is a form of energy, which is propagated as an electromagnetic wave. It is the radiation which makes our eyes able to see the object.
- Since, electromagnetic waves are transverse, hence light energy is also represents transverse wave.

- The light energy emitted from the sun takes 8 minute 19 second to reach on the earth. The speed of light is 3×10^8 m/s.
- When light falls on the surface of an object it can be absorbed, transmitted or reflected.
  - **Absorption of light:** The absorption process said to occur when an object absorbs all or some fraction of the light falling on it. If an object absorb all light falling on it, will appear perfectly black. For example: a blackboard.
  - **Transmission of light:** The transmission process said to occur when an object transmits light i.e. it allows light to pass through itself and such objects will appear transparent. For example : a glass jar.
  - **Reflection of light:** The reflection process said to occur when an object sends back light rays falling on its surface. In other words, when a ray of light falls on a boundary separating two media comes back into the same media, then this phenomenon is called the reflection of light. For example : a mirror.

Laws of Reflection of light

There are two fundamental laws of reflection of light:

(i) The angle of incidence is equal to the angle of reflection.

(ii) The incident ray, the reflected ray and the normal to the mirror at the point of incidence all lie in the same plane.

Do You Know?

Due to refraction from Earth's atmosphere, the stars appear to twinkle.

Laws of Refraction of Light

There are two laws of refraction:

(i) The incident ray, the refracted ray and the normal at the point of incidence all three lie in the same plane.

(ii) The ratio of sine angle of incidence to the sine angle of refraction remains constant for a pair of media i.e.

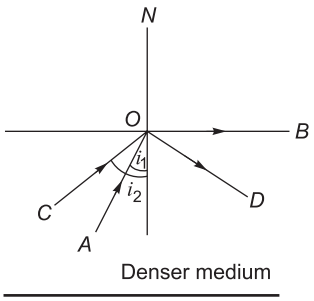
Sin i /Sin r = μ_2/μ_1 = constant, this law is known as Snell's law.

Where μ_1 and μ_2 are refractive indices of two different mediums.

Critical Angle (c)

The angle of incidence in a denser medium for which the angle of refraction in rarer medium becomes 90°, is called the critical angle.

Total Internal Reflection



When light is incident from denser to rarer medium, it bends away from the normal drawn at the incident point.

Let us consider two light-rays viz. AO and CO incident at point O from denser to rarer medium. Ray AO is incident at angle i_1. Its angle of refraction is <NOB = 90°. The refracted ray OB is parallel to the surface of denser medium. This angle is called as Critical angle (i_1 = c). Ray CO is incident at an angle $i_2 > i_1$. Its refracted ray is OD in the denser medium. It means when a light ray is incident at an angle greater than the critical angle, it returns back to the same medium. This phenomenon of returning back of a light ray in the denser medium is known as T.I.R.

Conditions for T.I.R.: Light should be incident from denser to rarer medium and (ii) The angle of incidence should be greater than the critical angle (c).

Mirror

Spherical Mirror

It is a type of mirror which has the shape of a piece cut-out of a spherical surface.

There are mainly two type of spherical mirrors:

1. **Concave mirror:** The image formed by a concave mirror is generally real and inverted.

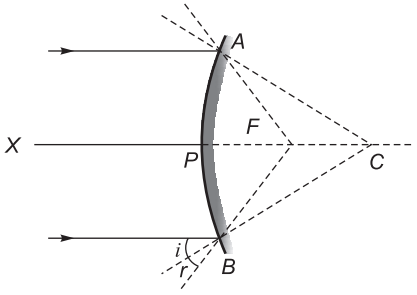
   Uses of Concave Mirror

   - As a shaving mirror
   - As a reflector for the headlights of a vehicle, searchlight, etc.
   - In ophthalmoscope to examine the eye, ear, nose by doctors. In solar cookers, etc.

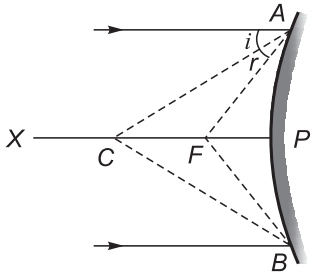
2. **Convex mirror:** The image formed by a convex mirror is always virtual, erect and diminished.

Uses of Convex Mirror

- As a rear view mirror in the vehicle because it provides the maximum rear field of view and image formed is always erect.
- In sodium reflector lamp.



Convex mirror



Concave mirror

P = Pole
PX = Principal axis
C = Centre of Curvature
PC = Radius
F = Focus
PF = Focal Length
A & B : Incident points
AC & BC = Normal drawn at incident points

Image formation in a convex Mirror

It always produces virtual and diminished image irrespective of the position of the object.

Real Image : It is always inverted and in front of the concave mirror.

Virtual Image : It is always erect and behind the concave and convex mirror. Focal length is half of the radius of curvature ($f = R/2$).

Mirror Formula :

$$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}=\frac{2}{R}$$

Where, u = objects distance from the pole of mirror. v = image distance from the pole of mirror. f = focal length of the mirror. R = radius of curvature of the mirror.

Magnification or Linear Magnification (m).

$$= \frac{\text{Size of image}}{\text{Size of object}} = \frac{\text{Image distance}}{\text{Object distance}}$$

Spherical Aberration: The inability of a concave mirror of a larger size to converge all rays parallel to the principal axis at the focus, is called spherical aberration. It can be removed by using a parabolic concave mirror of larger aperture.

Basic Terms related to Spherical Mirrors

1. **Centre of Curvature (c):** The centre of the hollow glass sphere of which the mirror is a part, is known as centre of curvature.
2. **The radius of Curvature (R):** The radius hollow sphere of which the mirror is a part, is known as radius of curvature
3. **Pole (P):** The mid-point of a spherical mirror is called pole.
4. **Focus (F):** When a parallel beam of light rays is incident on a spherical mirror then after reflection it meets or appears to meet at a point on the principal axis, called focus of the spherical mirror.
5. **Focal length (f):** It is the distance from the pole of mirror to its focus.

   Focal length= R/2, where R is radius of curvature.
6. **Principal axis:** The Principal axis of a spherical mirror is the straight line passing through the centre of curvature and pole of a spherical mirror, produced on both the sides.
7. **Aperture:** The portion of the mirror from which the reflection of light actually takes place is called the aperture of the mirror, it is also called linear aperture of the mirror.

Refraction of Light

When light goes from rarer (e.g. air) to a denser (e.g. glass) medium, it bends towards the normal to the interface, separating these two media. On the other hand, when light goes from a denser to rarer medium, it bends away from the normal to the interface separating these two media. This phenomenon is known as refraction of light.

Q.1 A liquid is kept in a regular cylindrical vessel up to a certain height. If this vessel is replaced by another cylindrical vessel having half the area of cross-section of the bottom, the pressure on the bottom will
(a) Remain unaffected
(b) Be reduced to half the earlier pressure
(c) Be increase to twice the earlier pressure
(d) Be reduced to one-fourth the earlier pressure

Q.2 In SONAR, we use
(a) Ultrasonic waves
(b) Infrasonic waves
(c) Radio waves
(d) Audible sound waves

Q.3 Two identical piano wires have same fundamental frequency when kept under the same tension. What will happen if tension of one of the wire is slightly increased and both the wire are made to vibrate simultaneously?
(a) Noise (b) Beats
(c) Resonance (d) Non-linear effects

Q.4 Which one among the following correctly defines a unit magnetic pole strength in SI units?
It is the pole which when placed in air at a distance of
(a) 1 foot from an equal and a similar pole repels it with a force of 1 pound
(b) 1 metre from an equal and similar pole repels it with a force of 1 newton
(c) 1 cm from an equal and a similar pole repels it with a force of 1 dyne
(d) 1 metre from an equal and a similar pole repels it with a force of 1 newton/m^2

Q.5 Which one of the following phenomena is associated with the fire flies giving cold light in night?
(a) Fluorescence
(b) Phosphorescence
(c) Chemiluminescence
(d) Effervescence

Q.6 When you pull out the plug connected to an electric appliance, you will often observe a spark. To which property of the appliance is this related?
(a) Resistance
(b) Inductance
(c) Capacitance
(d) Wattage

Q.7 In scuba diving, while ascending towards the water surface, there is a danger of bursting the lungs. It is because
(a) Graham's law of diffusion
(b) Archimedes' principle
(c) Boyle's law
(d) Henry's law

Q.8 An athlete diving off high springboard can perform a variety of exercise in the air before entering the water body. Which one of the following parameters will remain constant during the fall?
(a) The athlete's linear momentum
(b) The athlete's angular momentum
(c) The athlete's kinetic energy
(d) The athlete's moment of inertia

Q.9 Why are the inner lining of hot water made up of copper?
(a) Copper has less heat capacity
(b) Copper has high electrical conductivity
(c) Copper does not react with steam
(d) Copper is good conductor of both heat and electricity

Q.10 Which one of the following forces lead to separation of the cream from the churned milk?
(a) Gravitational force
(b) Cohesive force
(c) Centripetal force
(d) Centrifugal force

Q.11 By which one of the following, an old written material which cannot be read easily can be read?
(a) Alpha-rays
(b) Beta-rays
(c) X-rays
(d) IR-rays

Q.12 'Mirage' is a phenomenon due to
(a) Reflection of light
(b) Refraction of light
(c) Total internal reflection of light
(d) Total diffraction of light

Q.13 Neutron was discovered by
(a) Rutherford
(b) Chadwick
(c) Hahn and Strassman
(d) Millikan

Q.14 The blackboard seems black because it
(a) reflects every colour.
(b) does not reflect any colour.
(c) absorbs black colour.
(d) reflects black colour.

Q.15 If the spinning speed of the earth is increased then the weight of body at the equator
(a) increases (b) decreases
(c) doubles (d) does not change

Q.16 A solid sphere, disc and solid cylinder all of same mass and made of same material are allowed to roll down (from rest) on incline plane then
(a) disc will reach the bottom first
(b) solid sphere will reach the bottom first
(c) solid cylinder will reach the bottom first
(d) All of them will reach the bottom at the same time

Q.17 The melodious effect on our ear produces by the combination of two or more notes of the modern pop songs is called
(a) concord (b) chords
(c) beats (d) overtones

Q.18 Which of the following statements given below is correct in the respect of a geostationary satellite?
(a) It moves in a plane containing the Greenwich meridian
(b) It moves in a plane perpendicular to the celestial equatorial plane
(c) Its height above the earth's surface is about the same as the radius of the earth
(d) Its height above the earth's surface is about six times the radius of the earth

Q.19 Which one of the following phenomena shows particle nature of light?
(a) Polarisation
(b) Photo-electric effect
(c) Interference
(d) Refraction

Q.20 What is the function of a microphone?
(a) Convert sound signals to electric signals
(b) Convert electric signals to sound signals
(c) Convert sound signals to electromagnetic waves
(d) None of the above

Q.21 Why is it difficult to transmit audio signals directly?
(a) A very high antenna is needed for their propagation
(b) Audio signals have a very high frequency
(c) Audio signals can't propagate alone
(d) Audio signals can't propagate through air

Q.22 The impurity atom with which pure silicon should be doped to make a p-type semiconductor are those of
(a) Phosphorus
(b) Boron
(c) Antimony
(d) Arsenic

Q.23 Optical fibre mainly used in communication is based on
(a) less absorption coefficient
(b) less scattering
(c) total internal reflection
(d) refraction

Q.24 Why is it easier to swim in sea water?
(a) Atmospheric pressure is highest at the sea
(b) Sea water contains salt
(c) Density of sea water is higher than the ordinary water
(d) None of the above

Q.25 If there were no gravity, which of the following will not be there for a fluid?
(a) Viscosity
(b) Pressure
(c) Archimedes' upward thrust
(d) Surface tension

Q.26 When the light is passed through a prism, the colour which deviates least is
(a) red (b) green
(c) violet (d) blue

Q.27 If door of a running refrigerator is kept open in a closed room, what will happen to the room?
(a) It will cool the room
(b) It will heat the room
(c) It will make no difference on the average
(d) It will make the temperature go up and down

Q.28 A perfect black body has the unique characteristic feature as
(a) a good absorber only
(b) a good radiator only
(c) a good absorber and a good radiator
(d) Neither an absorber nor radiator

Q.29 Which one of the following is used to determine the age of human fossils?
(a) Density determination of fossil
(b) Softness of the fossil
(c) Radio-carbon dating
(d) Water content of the fossil

Q.30 How is the pressure cooker work?
(a) Heat cannot escape from the cooker
(b) Low pressure inside the cooker rises the boiling point of water
(c) High pressure inside the cooker rises the boiling point of water
(d) Steam inside the cooker makes food to cook with ease

Q.31 Soap helps in the cleaning of cloths because
(a) it reduces surface tension
(b) it increases surface tension
(c) it absorbs the dirt
(d) of some other reason

Q.32 An n-type and p-type silicon can be obtained by doping pure silicon with
(a) arsenic and phosphorus
(b) indium and aluminium
(c) phosphorus and indium
(d) aluminium and boron

Q.33 A mirror produces magnified erect image of an object. The nature of the mirror is
(a) convex
(b) concave
(c) plane
(d) Neither convex nor concave

Q.34 Stars are twinkling due to
(a) diffraction (b) refraction
(c) scattering (d) reflection

Q.35 In the winter, we get warmer by using two blankets instead of one, why?
(a) Two blankets are thicker, so generate more heat
(b) Two blanket enclose air which does not allow the cold to penetrate
(c) Two blanket compress the air between the body and the blankets
(d) None of the above

Q.36 Which of the following is a ferromagnetic material?
(a) Nickel
(b) Quartz
(c) Bismuth
(d) Aluminium

Q.37 A table cloth can be pulled from a table without dislodging the dishes. It is because of
(a) Graham's law of diffusion
(b) Archimedes principle
(c) Newton's first law
(d) Newton's second law

Q.38 In a nuclear reaction, which one of the following is conserved?
(a) Atomic number
(b) Mass number
(c) Atomic number, mass number and energy
(d) None of the above

Q.39 When the matter is cooled to very low temperature, it will form
(a) semi-conductor
(b) super-conductor
(c) insulator
(d) capacitor

Q.40 Which among the following waves is used for communication by artificial satellites ?
(a) Microwaves
(b) Radio waves
(c) A. M.
(d) Frequency of 1016 series

Q.41 Why the needle of iron swims on water surface when it is kept gently ?
(a) It will remain under the water, when it will displace more water than its weight
(b) the density of needle is less than that of water
(c) due to surface tension
(d) due to its shape

Q.42 Rain drops fall from great height. Which among the following statements is true regarding it?
(a) they fall with that ultimate velocity, which are different for different droplets
(b) they fall with same ultimate velocity
(c) their velocity increases and they fall with different velocity on the earth
(d) their velocity increases and they fall with same velocity on the earth

Q.43 Which one of the following is used for sun glasses ?
(a) Pyrex glass
(b) Flint glass
(c) Crooks glass
(d) Crystal glass

Q.44 When the barometer reading dips suddenly, it is an indication of
(a) Hot weather
(b) Calm weather
(c) Storm
(d) Dry weather

Q.45 Solar energy is converted into chemical energy during
(a) Transpiration
(b) Photosynthesis
(c) Diffusion
(d) Osmosis

Q.46 In which of the following cases, kinetic energy is being used in performing work ?
(a) Paddling the bicycle to cover a distance
(b) Driving a car to cover a distance
(c) Wind mill grinding wheat grain
(d) Rowing a boat in the lake

Q.47 If the velocity-time graph of a particle is represented by $y = mt + c$, then the particle is moving with
(a) constant speed
(b) constant velocity
(c) constant acceleration
(d) varying acceleration

Q.48 Longitudinal waves cannot travel through
(a) Vacuum (b) Solid
(c) Liquid (d) Gas

ANSWER KEY ▶ PHYSICS

1. (c)	**2.** (a)	**3.** (b)	**4.** (b)	**5.** (c)	**6.** (a)	**7.** (c)	**8.** (b)	**9.** (d)
10. (d)	**11.** (d)	**12.** (c)	**13.** (b)	**14.** (b)	**15.** (b)	**16.** (b)	**17.** (a)	**18.** (d)
19. (b)	**20.** (a)	**21.** (a)	**22.** (b)	**23.** (c)	**24.** (c)	**25.** (b)	**26.** (a)	**27.** (b)
28. (c)	**29.** (c)	**30.** (c)	**31.** (a)	**32.** (c)	**33.** (b)	**34.** (b)	**35.** (b)	**36.** (a)
37. (c)	**38.** (c)	**39.** (b)	40. (a)	**41.** (c)	**42.** (a)	**43.** (c)	**44.** (c)	**45.** (b)
46. (b)	**47.** (c)	**48.** (a)						