Archimedes Principle : It states that when a body is wholly or partially submerged in a fluid, it experiences an upward force which is equal to the weight of the fluid it displaces and which acts through the centre of buoyancy.

Atmospheric Pressure : The atmosphere is the name given to the thin layer of air that surrounds the earth. Air has mass and weight, and the weight of atmosphere exerts a pressure of 100,000 Nm^{-2} on the surface of earth. This pressure is known as atmospheric pressure. The atmosphere is not uniform: its density decreases with increasing altitude. The inside of a high-flying jet aircraft has to be pressurized so that the passengers can sit in normal atmosphere. Atmospheric pressure is measured using a barometer.

Surface Tension : The surface of a liquid is under a state of tension because of the attraction exerted on the surface molecules by the molecules beneath. The surface thus tends to contract as much as possible and acts like a stretched elastic membrane.

Capillary Action : Capillarity is a general term for phenomenon observed in liquids due to unbalanced intermolecular attraction at the liquid boundary, *e.g.*, the rise or depression of liquids in narrow tubes, the formation of films, drops, bubbles, etc.

Pressure in Liquids : The pressure of the liquid depends upon the density, height of the liquids and gravitational pull of the earth by the formula phg. Pressure increases with depth in a liquid. The liquid shoots out farthest from the bottom hole of a can with three holes in a vertical row because the pressure is greater there.

Sinking and Floating : If an object is not hollow but is of uniform density, it will either sink or float when fully immersed in liquid, what it does will depend both on the density of the object and on the density of the liquid.

Fluid : The word fluid is used both for liquids and gases. A liquid has a fixed volume and assumes the shape of its container. Molecules in the liquid state have an attraction for each other. This attraction draws the molecules together. Gaseous state is also fluid. A gas takes the shape of its container. The volume of a gas is not fixed. It will expand to fill any container or until a force begins to hold it back.

Bernoulli's Principle : When the speed of a fluid in a pipeline increases, the pressure decreases and conversely when the speed of a fluid decreases, the pressure increases. The application of this principle is in the flying of an aeroplane and the curved trajectory of a spinning cricket ball.

Application of Gases Under High Pressure

The application of gases under high pressure saves a man a great deal of labour. When new bridges are built on river, the foundation have to be laid under water. A caisson is sunk for this purpose, it has a huge tank open at the bottom. Air is then forced into the caisson at pressures high so that it hold back the surrounding water and workmen can enter or leave the caisson and material could be transferred to it.

Role of Vacuum : Vacuum plays a constant and practical role in our life today. In modern dairies, cows are milked by machines which is a special kind of vacuum pumps. In vacuum cleaner, an electric motor causes a fan to create a vacuum inside the nozzle and as air rushes into fill up the vacuum it carries particle of dust, lint, etc. with it.

WORK, ENERGY AND POWER

Work : When a force acts on a body and produces motion then work is said to be done.

If the magnitude of the force is F and the distance through which the body moves is d, the work

$$W = Fd$$

The S.I. unit of work is Joule and also Newtonmetre.

Energy : It is defined as the capacity to do work and measured by the amount of work done by the body. There are various kinds of energy but in mechanics, energy is classified into two kinds, *i.e.*, kinetic and potential.

Kinetic Energy **:** It is the energy which is possessed by a body by virtue of its motion.

Kinetic Energy = $1/2\ mv^2$; where m is the mass of the body and v is the speed.

Potential Energy : It is defined as the energy possessed by a body by virtue of its position of rest. Potential energy of a body is calculated by measuring the total amount of work done by a body to fall from a certain height upto the ground.

Potential Energy = mgh, where m is the mass, g is the acceleration due to gravity and h is the height above ground.

Law of Conservation of Energy : Energy can neither be created nor be destroyed but can be transferred from one form to another. Total energy of the system remains conserved in all natural processes.

Machines

Simple machines : The following six basic elements are called simple machines :

1. Lever
2. The inclined plane
3. The wedge
4. The screw
5. The wheel
6. The pulley

HEAT

It is a form of energy consisting of motion of molecules inside the matter. Heat can also be defined as the form of energy by which we feel hotness in a body. In the absence of heat a body is felt cold.

Sources of Heat : The major sources of heat are ; (*i*) the sun, (*ii*) burning coal or oil, (*iii*) friction, (*iv*) electric current, and (*v*) chemical reactions.

Temperature : Temperature of a body is a number which expresses the degree of hotness of a body on the basis of suitable scales known as scales of temperature. The three main scales of temperature are (*i*) Celsius, (*ii*) Fahrenheit, (*iii*) Reaumer. The most accurate and sensitive scale of temperature used now-a-days is Kelvin.

Celsius and Fahrenheit : The numbers on the thermometer scales are merely historical choices; they are not scientifically fundamental. The most widely used scales are the Fahrenheit (°F) and the Celsius (°C). The centigrade scale with 0° assigned to ice water (ice point) and 100° assigned to water boiling under one atmosphere pressure (steam point) was formerly used, but it has been succeeded by celsius scale, defined in a different way than the centigrade scale. However, on the celsius scale the temperatures of the ice and steam points differ only by a few hundredths of a degree, from 0° and 100°, respectively.

Comparisons of Temperature Scales

	Kelvin	*Celsius*	*Rankine*	*Fahrenheit*
Steam Point	373	100°	672°	212°
		↑ 100 K or C ↓	↑ 180°R ↓	
Ice Point	273	0°	492°	32°
Solid CO_2	195	78°	351°	109°
Oxygen Point	90	183°	162°	297°
Absolute Zero	0	273°	0°	460°

Absolute Zero : In 1848 William Thompson (Lord Kelvin) conceived of a body which did not give up any heat and which was at an absolute zero of temperature. It has shown that absolute zero corresponds to −273.16° or −459.7°F. Two absolute scales shown in the above table are the Kelvin (K) and the Rankine (R°).

Types of Thermometer

1. *Liquid-in-glass thermometer* : It has range to measure the temperature between −300°F and +1200°F.
2. *Clinical thermometer* : It measures over a very limited range of 35°C to 43°C.

3. Bi-metallic thermometer.
4. Resistance thermometer.
5. Thermocouple.
6. *Pyrometer* : It can measure temperature about 900°K.

Transmission of Heat : There are three common ways by which heat energy can be made to go from one point to another. They are conduction, convection and radiation.

Conduction : In conduction heat is passed from one body to another by actual contact. It is a process of net energy transfer through a substance without movement of the substance itself. The rate of transfer depends on the sample length and cross-sectional area, the temperature difference and the nature of the material.

Convection is the transference of heat through a liquid or gas by the actual movement of the fluid. Portions in contact with the source of heat become hotter, expand, become less dense and rise. Their place is taken by colder portions, thus setting up convection currents.

Radiation is the transfer of heat by a wave motion like light. It takes place in vacuum as well as in air. The warmth we feel as we spread our hands before an open fire is radiant heat. Heat from the sun is radiant heat

Newton's Law of Cooling : The rate of loss of heat from a body is proportional to the excess temperature of the body over the temperature of its surrounding, *i.e.*, called Newton's law of cooling.

The Greenhouse Effect : Infra-red radiation from the sun has a short wavelength and it passes through glass without being absorbed. It is absorbed by the plants in the greenhouse raising their temperature. The plants also radiate heat but a much longer wavelength which cannot penetrate glass. The greenhouse is able to trap heat and can do this efficiently even on a dull day. The same principle is applied behind having a glass lid for a solar cooker.

Application of Principles of Transfer of Heat

Thermo Flask : It is nothing but a bottle within a bottle, the two being united only around the lip. Outer portion of flask is made of insulator so that heat cannot be transferred from the bottle to the outer one by convection and from surrounding to inner portion and by this way thermos bottle can be kept hot or cold for twenty-four hours or longer.

Melting Point : The constant temperature at which a solid changes into the liquid form is called its melting point. In the case a substance changes from solid to liquid state.

Boiling Point : The constant temperature at which a liquid begins to boil under a given pressure is called boiling point. In this case, a substance changes from liquid to vaporous state. It has been seen that the boiling point of a liquid increases with increase in pressure.

Dew Point. The temperature at which a given mass of air becomes saturated with the amount of water vapours already present in it is called dew point. The condensed water particles are called dews. Dews are generally seen on bad conductors of heat. During a clear sky dews are formed quickly.

Mechanical Equivalent of Heat. The ratio between the energy lost in a mechanical process and the heat produced in the process is constant. It is expressed in joule (1 calorie = 4.2 joules).

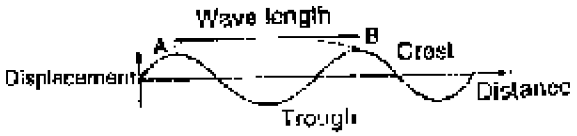
WAVES

NATURE OF WAVE

Wave is a way in which certain forms of energy can be moved from one place to another. In a quiet pool of water ripples are formed when an object strikes the surface of the water. Any kind of wave must have a medium to travel in. Each wave has its own wavelength, frequency, amplitude and form. Radiant energy is carried by electromagnetic waves.

Transverse and Longitudinal Waves : The motion of the particles is perpendicular to the direction in which the wave moves. It is called a transverse wave, *e.g.*, wave, spreading on the surface of water, and vibrations of a string. In longitudinal waves the particles move along the direction of motion of the waves. *e.g.*, sound waves in air transverse waves form crests and trough while longitudinal waves travel in the form of compression and rarefactions.

The time taken to complete one vibration is called time period and is denoted by *T*. The number of vibrations per second is called frequency. The distance between any two consecutive troughs is always the same and is called the wavelength of the periodic wave and is denoted by Lambda (λ). The height or displacement of a wave above or below its position of equilibrium is called its amplitude.



PROPERTIES OF WAVES

Superposition : Two or more waves can traverse the same medium independent of one another. When the displacements of the individual waves are in the opposite direction, they tend to cancel each other. The process of vector addition of the displacements of waves is called superposition.

Interference : The superposition of two or more waves originating from a common source, but transversing different paths, results in regions in he transmitting medium at which there is a inimum intensity and in other regions at which ere is a maximum intensity. This phenomenon is med as interference. Interference can also be duced by waves from different sources.

Reflection : When a wave strikes a surface eparation of two different media, some is thrown into the original medium. This property of cing of the waves is called reflection. The angle idence is equal to the angle of reflection. Use nd reflection as a basis of navigation is made s, which cannot see in the dark.

olarization : This property distinguishes se waves from longitudinal waves. In the transverse waves, the displacement of the of the medium is perpendicular to the direction of propagation and can be in any one of the infinite directions. When the displacement patterns of a transverse wave lie in a single line, the wave is said to be plane-polarized.

Electromagnetic Radiation : Energy transmitted through space or through a material medium in the form of electromagnetic waves is called electromagnetic radiation.

Application of Radiation

X-ray : 1. In surgery
2. In engineering
3. In therapeutics
4. In detective departments.

Ultraviolet-ray : In killing germs.

Infra-red Radiation : In drying in a automobile industry

Diffraction : It is the property of waves of turning round the edges of an obstacle. For diffraction to be observed, the size of the obstacle should be comparable to the wavelength of the waves. Sound can be heard around a corner due to diffraction.

Refraction : When a wave passes from one medium to another it is usually bent since the waves travel at different speeds in different materials. The ratio of the wave lengths in the two media equals the ratio of the speeds.

SOUND

Two most common forms of waves we encounter in daily life are sound waves and light waves. Sound waves are also known as elastic waves. Sound may be characterized essentially by three properties : (*i*) loudness, (*ii*) pitch, (*iii*) quantity. The frequency range from 20 Hz to 20,000 Hz which produces the sensation of hearing is called the audible range. Waves with frequencies above the audible range are called ultrasonic waves and those with frequencies below the audible range are called infrasonic waves. Bats can hear upto 120,000 Hz. Infrasonic waves are usually produced by large sources. Loudness of sound waves depends upon the amplitude of vibration of the sound making object and on the distance from the object to the ear.

The power produced by a sound wave as it passes through an area at right angles to the direction of the wave is called the intensity of the sound in that area. The intensity of sound can be accurately measured by the electronic device known as a noise meter or sound meter. It measures the sound in decibel. One decibel represents an increase in intensity of 26% which is about the smallest change which the ear can detect.

Pitch : The highness or lowness of a sound is called its pitch. It depends upon the speed of vibration of the sounding object.

Quality : All the sounds of the same frequency would sound more or less alike. We can distinguish between such sounds largely because of their difference in quality or timbre. Quality is chiefly a matter of overtones.

Beats : If two sound notes of slightly different frequencies are sounded together, waxing and waning of sound is heard. This is known as beats. The frequency of beats is equal to the difference between the frequencies of the two notes.

Reflection of Sound Echoes : Sound waves can be reflected and echoes produced. If the reflection takes place at a rigid reflector, a phase change of 180° takes place.

Standing or Stationary Waves : When two identical waves moving in opposite directions interfere, the shape appears to be stationary. Such waves are known as stationary waves. These waves are of same amplitude and same wavelength but travel in opposite directions.

Resonance of Sound Waves : Resonance is a phenomenon of forced vibration due to which sound waves can be produced with a large amplitude or intensity. All bodies have their natural frequency of vibration. When we apply a small signal of the same frequency to the body, the signal is greatly amplified and it is called resonance.

Musical Sounds : They are characterized by the sensations of pitch, loudness and quality. A musical instrument consists of a generation and resonator.

Ultrasonic Wave : They are waves of high frequency. Its frequency is higher than 20,000 Hz.

Application of Ultrasonic waves

1. In determining the depth of sea.
2. In formation of alloys.
3. In soldering.
4. In sterilization.
5. In medicine.

LIGHT

NATURE OF LIGHT

It is a form of radiant energy and it is the external physical cause which produced in us the sensation of sight and subsequently enable us to see things around us. It consists of waves or particles but it like waves in certain respects and particles in others. The speed of light is nearly 3.0×10^8 m/sec.

Rectilinear Propagation of Light

Light travels in a straight line in a homogeneous medium and this behaviour of light is called rectilinear propagation of light.

Photometry : It deals with the measurement of the quantity of light. The intensity of illumination is called *phot*.

Shadow : If an opaque body is placed in the path of light rays coming from a source then either some amount of light passes through it or no light passes at all resulting in the formation of a dark figure called shadow. There are two types of shadows : (1) umbra, (2) penumbra. The umbra region is complete dark whereas the penumbra region is partially dark.

Eclipses : A *solar eclipse* occurs when the moon comes in between the sun and the earth and a *lunar eclipse* is formed when the earth comes in between the moon and the sun.

Reflection of Light : When the light energy falls on a polished surface it comes back to the same medium obeying certain laws. This phenomenon is called reflection of light. Generally when light energy falls on any surface the part of it is reflected and the remaining part absorbed. If the surface is polished, then a great percentage of light energy is reflected. Mirrors reflect light.

Law of Reflection : 1. The angle of incidence is equal to the angle of reflection, 2. The incident ray, the reflected ray and the normal at the point of incidence to the reflecting surface all lie in the same plane.

Image : When rays of light after refraction or reflection actually converge at a point or diverge from a point then this point is called the image of the object. An image can be real or virtual. Real image is formed when reflected or refracted rays actually converge, and virtual image is formed when reflected or refracted rays diverge from a point. Real image can be obtained on a screen. Virtual image cannot be obtained on a screen. Real image is always inverted whereas virtual image is always erect. A plane mirror always gives virtual and equal sized image of an object. When two plane mirrors are kept parallel to each other infinite number of images are formed, but when they are kept at an angle with each other, then the number images formed

$$= \frac{360^\circ}{\text{Angle between the mirrors}} - 1$$

Concave mirrors give both real and virtual image but convex mirrors always give diminished and virtual image. Due to this concave mirrors are used as reflectors and for shaving purpose, whereas convex mirrors are used as rear view mirrors.

Refraction of Light : When a ray of light travels from one transparent medium to another transparent medium of different density it bends at the surface of separation of the two media. This bending of light is called refraction of light.

LAWS OF REFRACTION

First Law : The incident ray, the refracted ray and the normal to the surface at the point of incidence lie in one plane.

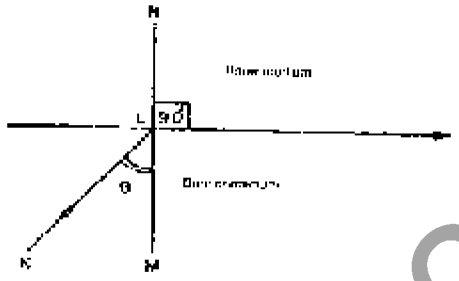
Second Law : The ratio of sine of angle of incidence to the sine angle of refraction is constant quantity for any given media.

It is named as refractive index and is represented by a letter μ and mathematically,

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

It is also known as Snell's Law.

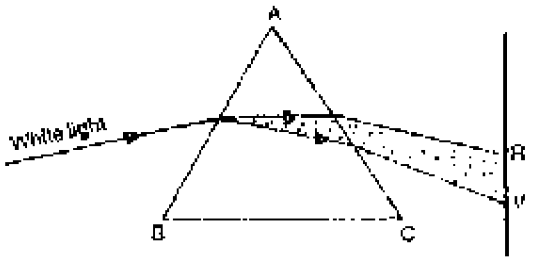
Critical Angle : When a ray of light travels from a denser medium to a rarer medium, then the angle of incidence for which the angle of refraction in the rarer medium is 90° is said to be critical angle of the medium.



Total Internal Reflection : When a ray of light travels from denser medium to rarer medium and the angle of incidence becomes greater than the critical angle, then the whole amount of light gets reflected. This is called 'total internal reflection'.

Mirage : On the basis of total internal reflection 'mirage' takes place in the desert. In sandy deserts, the lowermost layer being closest to the earth is rarest medium; the upper layers become denser, one after the other. Light rays coming from the top of a tree get refracted away from the normal (each time) because they travel from denser to rarer medium (total internal reflection). The inverted image of the tree is seen by the observer, who moves towards the tree. He, therefore, imagines the presence of water there but actually it is mirage.

Prism : It is a solid figure of any transparent medium having five surfaces. The top and the bottom surface are triangular and the side surfaces are rectangular. It refracts light. When a ray of white light passes through a prism it is decomposed into seven colours which are remembered by the letters of the word 'VIBGYOR'. The different colours are violet, indigo, blue, green, yellow, orange and red. The breaking up of white light into seven colours is called dispersion of light. The band of seven colours is called *spectrum*.



Monochromatic Light : Light of a single colour of a single wavelength is referred to as monochromatic.

Lens : A lens is a piece of transparent glass material bounded by two curved surfaces or by one plane and one curved surface. A lens also refracts light like a prism. Mostly lenses are of two types : (*i*) convex lens, (*ii*) concave lens.

A convex lens is also called converging lens and a concave lens is called diverging lens.

Lenses are used in optical instruments, *e.g.*, magnifying glass, compound microscope, astronomical telescope, spectacles and camera.

Human Eye : It may be considered an optical instruments similar to the photographic camera. Its convex lens forms a small and inverted image of the external objects on the retina.

Defects of Vision and Their Remedies

(*i*) ***Short-sightedness (Myopia)*** : When a person is unable to see distant objects then this defect of vision is said to be short sight. In this case the image of distant object is formed before retina and by using a concave lens (diverging lens) the rays of light are brought on the retina.

(*ii*) ***Long-sightedness (Hypermetropia)*** : When a person is able to see distant objects but is not able to see nearer objects, then this defect of vision is said to be long-sight. In case of a long sighted eye, the image of nearer object is formed beyond retina and by using a convex lens (converging lens) the rays of light are brought on the retina.

Presbyopia : This defect arises mostly in old age low power convex lenses are used to remove this defect.

Astigmatism : When the eye fails to distinguish horizontal and vertical lines at the same distance it is called astigmatism of the eye. Cylindrical or spherecylindrical lenses are used to remove this defect.

Power of Lens : The reciprocal of the focal length of a lens in meters is called power of a lens. Power of lens is expressed in dioptres.

OPTICAL INSTRUMENTS

1. *Projection Instrument.*
   e.g., camera, cinema projector etc.
2. *Microscope* : These are used to see very small objects.
3. *Telescopes and their adaptations* : These are used to see distant objects.
4. *Episcopes* : It is an instrument used for projecting magnified image or opaque objects Some episcopes have arrangement for slide. These are called epidiascopes.
5. *Cinematograph* : It is a device for projecting instantaneous pictures on a screen at a such a rate that a moving representation of the picture is produced.
6. *Periscope* : It is an instrument which makes us to view objects which are hidden the direct sight. There are two types of periscope : (*a*) Simple periscope, (*b*) Sub-marine periscope. They are used in aircrafts and nuclear reactors.
7. *Binocular* : It is an instrument by which the object is viewed with both eyes. It helps in seeing the object in depth, in getting a correct measurement of the distance objects and in providing more comfortable to the eyes.
8. *Laser* : It stands for 'Light Amplification by Stimulated Emission of Radiation'. It is an instrument which make a highly intense and concentrated beam of light which is highly directional extremely coherent and monochromatic.

APPLICATION OF LASER

1. Laser beams can be used to remove eye tumors and to hold detached retinas of human eye.

2. Larger distance can be measured very accurately by laser beam.
3. It helps in controlling rockets and satellite from ground.

ELECTRICITY

It is the energy by which a body attracts lighter bodies, *e.g.*, when we comb our hair for sometime and then take the comb near small pieces of paper, we find that the comb attracts the pieces of paper because the comb gets electricity due to friction.

Static Electricity : In this case electrical energy is confined in a body, it does not flow. There are two kinds of static electricity : (*i*) positive charge, (*ii*) negative charge. Static electricity is produced by friction. It has been seen that like charges repel each other and unlike charges attract each other.

Electric Current : When electrical energy flows from one place to another, then it is said to be electric current. The quantity of charge flowing through a wire in unit time is said to be current. S.I. unit of charge is coulomb and that of current is amperes. The substance through which current cannot flow is called *conductor* and the substance through which current cannot flow is called *insulator*.

Potential : Current flows from a point of high potential to the point of low potential like water which flows from high pressure to low pressure. S.I. unit of potential is *volt*.

Resistance : Resistance is the property of the material of a conductor by virtue of which it opposes the flow of current through it. S.I. unit of resistance is ohm. Resistance of a substance depends upon length, temperature, nature of material and cross-sectional area of the material.

Ohm's Law : The current flow through a conductor is directly proportional to the voltage applied across it.

Mathematically, $V \propto I$

$\therefore \quad V = IR$

Electrical Power : The ratio at which work is done in an electric current is called electrical power.

Mathematically, $P = V \times I = I^2R = \frac{V^2}{R}$.

Electrical Circuit

1. Series circuit
2. Parallel circuit
3. Series-parallel circuit
4. Short circuit.

Electrical Instruments

1. Galvanometer—to measure direction of current
2. Shunt—to restrict excess current
3. Ammeter—to measure current
4. Voltameter—to measure potential difference
5. Electromagnetism
6. Electric bell
7. Lifting magnet
8. Motor
9. Generator
10. Dynamo
11. Loudspeaker
12. Telephone
13. Transformer
14. Microphone
15. Diode and Triode
16. Transistor